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TRANSFORMATIVE PARTICIPATION IN A PROFESSIONAL COMMUNITY: A HOLISTIC CASE STUDY OF ONE EXPERIENCED TEACHER'S EVOLVING PRACTICE

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TRANSFORMATIVE PARTICIPATION IN A PROFESSIONAL COMMUNITY: A HOLISTIC CASE STUDY OF ONE EXPERIENCED TEACHER'S EVOLVING PRACTICE

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Education in the College of Education at the University of Kentucky

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ABSTRACT OF DISSERTATION

TRANSFORMATIVE PARTICIPATION IN A PROFESSIONAL COMMUNITY: A HOLISTIC CASE STUDY OF ONE EXPERIENCED TEACHER'S EVOLVING PRACTICE

This descriptive, holistic, single case study focuses on how an experienced teacher with 21 years of teaching was able to negotiate participation in a community of practice (CoP). The study applies Wenger's (1998) *Community of Practice* framework as a lens through which to gain insight into the subject's professional transformation. Wenger's multilayered theoretical approach, including the four components of his social learning model, provides a common language to describe participation.

The specific research questions that frame this inquiry are: 1) How did an experienced secondary mathematics teacher, involved in an ongoing and dual-faceted professional development project, negotiate meaningful participation in a community of practice? 2) How did the kinds of participation in which she chose to engage affect her professionally? and, 3) How did her classroom practice change?

Findings from the study include: 1) Wenger's Stages of Development (potential, coalescing, active, dispersed and memorable) for a CoP were in evidence in this teacher's participatory experiences. 2) Internal and external factors worked in concert to support

transformed practice. 3) The tension between experience and competence is an important factor when thinking about the difference between an expert and experienced teacher. 4) The case subject negotiated her participation through *intellectual partnerships* formed through the interaction with her *Peer CoP* and educational experts and researchers—an example of legitimate participation in authentic professional activities at a level quite different from most "teacher professional development" activities. The evolving shared repertoire of changed mathematical instructional practices was tangible evidence of transformative interactions. These findings indicate that a viable, robust CoP *can* be stimulated through external scaffolding and coordination of learning activities in combination with a joint enterprise of growth-minded professionals.

The data provide insight into the professional transformation that occurred within the case teacher's practice as she enacted the new, shared repertoire with students in her classroom. The new repertoire resulted in improved student learning not just during her active involvement in the CoP but after the community disperses, in a penultimate stage of a CoP described by Wenger (1998), suggesting that the results and transformed practice can be sustained.

KEYWORDS: Case Study, Community of Practice, Teacher Change, Experienced Teacher, Classroom Practice

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DEDICATION

To my father, Henry Zeidler and to my late mother, Nancy Mae Zeidler, who inspired me to complete my initial degree. My sisters Kathy Zeidler, Traci Zeidler Lash and Dr. Patti Zeidler Erdely, for their encouragement and support.

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Chapter One

INTRODUCTION

This descriptive, holistic, single case study focuses on an analysis of an experienced mathematics teacher's participation in a community of practice and the resulting changes in her classroom practice. The case subject, Danielle Jennings, has been teaching mathematics for twenty years in the Appalachian region of Kentucky. After two decades of teaching, Jennings applies to participate in a multi-year National Science Foundation (NSF) project focused on improving teacher practice and student learning. This case study is the story of how she negotiates her participation and why this participation differed from other kinds of professional development in which she had previously engaged.

The study applies Wenger's (1998) *Community of Practice* framework as a lens through which to gain insight into the subject's professional transformation. Wenger's multilayered theoretical approach, including the four components of his social learning model, provides a common language to describe participation in a community of practice (CoP). Specifically in the case study, I describe the ways in which Jennings negotiates her participation in a CoP that is engaged in joint professional activities. I also describe how the subject's participation affected her professionally and how that interaction ultimately affected her new shared repertoire of classroom practice and student learning.

In-depth studies of the ways in which an experienced teacher working in a rural setting rethinks his or her classroom practice and improves student learning outcomes through participation in structured professional community do not exist in professional literature. Further, the phenomenon of rethinking classroom practice has not been

examined in the context of a reform-oriented state, like Kentucky, where the Advanced Placement (AP) program has been expanded in high schools, including those with a rural or minority population. This study helps to provide insights into *the kinds of experiences* that allow for an experienced teacher to negotiate participation in a community of practice and how her participation affects what she does in the classroom.

Changing Teacher Practice

Despite the importance of K-12 schools in preparing students for college and future careers, the literature confirms that experienced teachers' conceptions of curriculum and mathematics teaching and learning can become stagnant or fixed over time (Leinhardt, 1983; Leinhardt & Greeno, 1986). Teachers can also become set in their beliefs about teaching and learning during their career. As a result, they may not provide adequate opportunities for students to learn and, in turn, may become resistant to external influences, such as professional development experiences, because they do not necessarily see a reason to change. This is especially the case for experienced teachers (Hargreaves & Fullan, 1998; Hargreaves, 1994; Huberman, 1992; Maurer, 1996). Furthermore, unless professional learning experiences confront what teachers believe about teaching and learning, provide for effective professional interaction, and allow teachers to explore new ideas in-depth, then minimal sustainable change will result (Sarason, 1990).

Nonetheless, the ongoing effectiveness of the classroom teacher appears to be one of the most critical factors in determining student achievement (NCTAF, 1996; Darling-Hammond, 2000). Darling-Hammond and Ball (1998) found that teacher quality is an important factor when looking at the variation in student achievement. Further, Darling-

Hammond and Rustique-Forrester (1997) argue that funds spent to improve teacher qualifications net greater gains in student learning than other educational expenditures. Therefore, Elmore (2002) and other educational reform researchers referenced above view improvement in teacher qualifications as a key component of current efforts toward educational improvement and systemic reform. Elmore asserts that professional learning experiences can play and integral role but "it has to be connected to the practice of improvement, and the structure of teachers' work life has to support a sustained process of learning" (p.29). Access to high quality professional development is necessary in education if a teacher's experience is to remain in tension with their competence (Wenger, 1998). If this does not happen, then a teacher may have 20 years of teaching experience, but his/her competence may not have kept pace with his/her experience.

In his *Community of Practice*, Wenger (1998) discusses why "the two-way interaction of experience and competence is crucial to the evolution of practice. In this interaction lies the potential for a transformation of both, and thus for learning, individually and collectively" (p.139). Wenger contends that when competence and experience are not in conflict with each other, then classrooms can have teachers who are experienced but who do not necessarily know how to meet the learning needs of their students. Indeed, to be effective, teachers must fully understand their discipline, which means they must be knowledgeable about both their subject matter and how their students learn (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Kennedy 1997; Fennema, Carpenter, Franke, Levi, Jacobs, & Empson, 1996). Fully understanding a discipline where student learning is the name of the game should help define a teacher's career competencies.

In 2005, the National Research Council released a report for teachers, *How Students Learn: Mathematics in the Classroom*. This report provides a framework highlighting four lenses—community, learner, knowledge, and assessment— that are used to describe what teachers must do to successfully help students learn mathematics. This shift to teaching with improved student learning as the overall goal requires that many teachers rethink their teaching practice and establish an effective classroom community that supports this goal.

To create an effective classroom community, teachers not only need to pay close attention to how they engineer instructional experiences, they also must pay close attention to students' dispositions or habits of mind, which include high student self-efficacy, so they can modify where necessary. Self-efficacy is the "confidence or strength of belief that we have in ourselves that we can make our learning happen" (Hattie, 2012, p.46). This belief is a central one in *How Students Learn: Mathematics in the Classroom*. Further, according to Hattie's research on "visible learning," the classroom culture can only be productive when teachers and students become partners in the learning process. Critical to this partnership is a positive student-teacher relationship—the community, or the first of the four "lenses" described in the National Resource Council report. According to Hattie's research, this relationship or *community* can significantly affect student learning, having an effect size of 0.72. He contends that once this relationship is established, students have an opportunity to learn from their mistakes, regular opportunities to learn from the application of a variety of strategies, and time to practice and receive feedback so they know what they need to work on to improve their learning

(Hattie, 2009), thereby addressing each of the other three lenses: learner, knowledge, and assessment.

Context for the Study: Kentucky External Mandates for Change

The knowledge that teachers need to effectively support student learning in their classrooms is once again at a critical juncture, in part due to the sweeping changes required of Kentucky schools and teachers as a result of recent legislative mandates. Changes that Kentucky mathematics teachers are currently working to implement include Kentucky Senate Bill 1 passed in March of 2009 that resulted in adoption of the Common Core State Standards (CCSS) in mathematics in 2010 and requirements around teacher effectiveness required under the current Kentucky Race to the Top (RTTT) initiative.

The vision of the Common Core State Standards requires teachers to orchestrate a learning environment where students engage in problem-solving and meaning-making (where students converse and support one another to make sense of what they are learning). Unfortunately, this vision is far removed from the reality of the teaching experience in many of our nation's classrooms. Indeed, this style of teaching is foreign to many, especially those whose only experience has been a model of instruction and learning that focuses heavily on memorization of knowledge without an emphasis on deeper understanding of subject standards and connections to big ideas within the subject (Cohen, McLaughlin, & Talbert, 1993; Darling-Hammond & McLaughlin, 1995). Further, many teachers have observed and experienced the factual type of learning during their time as students, which can influence their teaching style.

Implementing the vision espoused by the CCSS will require that districts, schools, and teachers examine their curriculum to ensure that the content is congruent to the new mathematics standards and that classrooms are set up to effectively support student achievement in mathematics as defined in *How Students Learn: Mathematics in the Classroom.* Teachers will need to rethink their teaching practices, and schools and districts will need to closely examine their curricula and assessments to redefine expectations for student learning. These expectations were part of the external mandate, Kentucky Senate Bill 1; therefore, this case study offers insights into how teacher participation in professional and communal experiences may result in their rethinking/changing their practice

Purpose

This study looks at the experience of one teacher's participation in a community of practice. The single-holistic study examines the participation and professional transformation using the lens of Wenger's *Community of Practice* framework.

Research Questions

The specific research questions that frame this inquiry are:

1. How did an experienced secondary mathematics teacher, involved in an ongoing and dual-faceted professional development project, negotiate meaningful participation in a community of practice?
2. How did the kinds of participation in which she chose to engage affect her professionally?
3. How did her classroom practice change?

Table 1.

Terminology

Term	Description
Communities of Practice	Can be thought of as shared histories of learning (Wenger, 1998, p. 86). Communities of practice provide a mechanism and place for professionals actively share "problems of practice" so that sup can be provided by others who share similar inte expertise, and strong relationships with one anot (p.41).
Ethos	The guiding beliefs of a person, group, or organization (Webster Dictionary online).
Interactive Professionalism	Based on the assumption that people need to fin ways of communicating with each other that wil support them to inquire into the effect their prac are having on student outcomes. The term was introduced by Fullan and Hargreaves (1996), wh it to describe the kinds of collegial relationships think educators need to develop in order to achie sustained improvement.
Negotiation of Meaning	Wenger defines "meaning" as one of the social learning components of his CoP social learning model. Negotiating meaning is an "ongoing pro that is shaped by multiple elements. In this ongo process, negotiation of meaning entails both interpretation and action. This process always generates new circumstances for further negotia and further meanings" (Wenger, 1998, p. 54).
Negotiation of Participation	"An active process that is both social and person which participants in a community of practice understand the *dimensions of their engagement*. Participation in social communities shapes our experience, and it also shapes those communitie transformative potential goes both ways" (Weng 1998, p.56).
Practice	"Both an explicit and tacit shared enterprises in people with explicit and tacit shared enterprises

Table 1 (continued)

	which people with common references can *susta* *mutual engagement in action"* (Wenger, 1998, p
Reification	"Process of giving form to our experiences by producing objects that congeal this experience in 'thingness'" (Wenger, 1998, p.58). "The produc reification are not simply concrete, material obje Rather, they are reflections of these practices, to of vast expanses of human meanings" (p.61).

Significance of the Study

Research confirms that changing a teacher's classroom practice is challenging and takes time (Wagner, 2004). Moreover, lack of support is one of the reasons many experienced teachers are particularly resistant to change (Hargreaves & Fullan, 1998; Hargreaves, 1994; Huberman, 1992; Maurer, 1996). By keeping in mind the dimensions of professional development that are most likely to affect what teachers do each day in their classrooms, we can design experiences that will help them improve their practice. We can do this by providing teachers opportunities to participate in professional learning experiences that can support sustained, mutual, and intellectual engagement through legitimate participation in a community of practice.

In Chapter Two I describe the conceptual framework and review relevant literature that frames this study. I also share background on the structured community of practice that Danielle Jennings joined in the spring of 2009 as part of her participation in the Appalachian Teacher Partner Project.

Chapter Two

LITERATURE REVIEW

Conceptual Framework

In this chapter, I present the conceptual framework and relevant literature review for this study. The first section focuses on social constructivism and Wenger's *Community of Practice* framework, which is derived from social learning and constructivist perspectives. In the literature review, I present the research on change and contingency theory as it relates to education and the degree to which the social constructivist views of the nature of learning align with what happens to promote professional learning in education. I then provide an explanation of Gowin's *Vee* diagram and a completed *Vee* for the research (see Figure 4). The *Vee* diagram serves as a visual representation showing the relationship of theory and practice in a conceptual framework for this research. I conclude the chapter by providing background on the Appalachian Teacher Partner Project to provide context for the findings.

Social constructivism. Specific assumptions about reality, knowledge, and learning form the basis for social constructivism. Social constructivists argue that reality is constructed through human activity. They also believe that reality cannot be discovered; it does not exist prior to its social invention. Additionally, social constructivists hold that knowledge is a human product, and it is socially and culturally constructed (Ernest, 1999; Gredler, 1997; Pratt & Floden, 1994). It is through these social interactions that the human mind is able to grow and through which meaningful learning can occur. Neuroscientists have been able to confirm what social constructivists theorized about the nature of learning: that the brain does not become fixed; instead, it develops

and grows overtime often as a function of the social activities in which people are engaged (National Research Council, 2000).

Social Participation as a Path to Learning. Wenger argues that "a social theory of learning must…integrate the components necessary to characterize social participation as a process of learning and of knowing" (Wenger, 1998, pp.4-5). He identifies these components as meaning, practice, community, and identity. Wenger goes on to say that these components are deeply and mutually interconnected. His theory supports what social constructivist have found: Lifelong learning begins with the premise that humans are social beings, and that learning occurs as part of and in response to social participation, resulting in what Wenger refers to as "collective learning." Wenger contends that

> Over time, this collective learning results in practices that reflect both the pursuit of our enterprises and the attendant social relations. These practices are thus the property of a kind of community created over time by the sustained pursuit of a shared enterprise. It makes sense, therefore to call these kinds of communities, *communities of practice* (p.45).

Communities of Practice and Participation. Lave and Wenger (1991) proposed a sociocultural theory to explain how the context of social development (Vygotsky, 1978) influences human social endeavors and generates practice, meaning, and identity. Wenger (1998) used the sociocultural theory of learning to further expand on identity and tied the elements together to propose communities of practice (CoP) as a social learning model.

Wenger states that CoPs combine three elements: joint enterprise, mutuality, and shared repertoire. Further, he says that,

> A history of mutual engagement around a joint enterprise is an ideal context for this kind of leading-edge learning, which requires a strong bond of communal competence along with a deep respect for the particularity of experience. When these conditions are in place, CoPs are a privileged locus for the *creation* of knowledge (p.214).

The CoP framework provides a mechanism to better understand how members interact within an ongoing community to continually learn from each other and create their shared repertoire.

Wenger (1998) outlines four premises that function as underlying assumptions about what matters in learning and applies these ideas to the CoP framework.

> We are social beings and this is a central aspect of learning; knowledge is a matter of **competence** with respect to the valued enterprise; knowing is a matter of participating and of active engagement in the world; and meaning—our ability to **experience** the world and our engagement with it as meaningful—is ultimately what learning is to produce (p.4).

Wenger defines learning as a "realignment of experience and competence that has the ability to transform our identities" (p.227). It is through this process of transformation that "learning can become a source of meaningfulness and of personal and social energy" (p.215) if experience and competency remain in tension with one another (p.214). This tension is crucial to the continual development of practice over time. Therefore, Lave and

Wenger's *Community of Practice* research has often been cited to describe and explain teacher learning in the field of mathematics education (Boaler & Greeno, 2001; Lerman, 1998; Stein & Brown, 1997; Watson, 1998).

Participation, as Wenger (1998) defines it, involves an encompassing process that goes beyond involvement in local events involving specific activities and specific people. "Participation situates practice in a larger context or broader constellation that is defined by *mutual engagement*" (p.141). Moreover, he argues that everyone belongs to multiple communities of practice at work at home, at school, and in our leisure activities, and that learning can occur through participations. However, Wenger's social theory of learning also involves being active participants in the practices of social communities and constructing identities in relation to these communities. He characterizes social participation as a process of learning and of knowing. Wenger relies on the four deeply and mutually interconnected and integrated elements that make up his social learning theory based on his earlier research with Lave (1991)—meaning, practice, community, and identity. The diagram below illustrates the four elements as components of a social theory of learning.

Figure 1. Components of Wenger's Social Theory of Learning (p.5)

According to Wenger, *practice* refers to "explicit and tacit shared enterprises in which people with common references can *sustain mutual engagement in action"* (p.5). He points out that one could "switch any of the four peripheral components with learning, place it in the center as the primary focus, and the figure would still make sense" (p.5). "Learning is not just an accumulation of skills and information, but a process of becoming" (p.215). Thus, through participation in communities of practice (CoP) where individual and group meanings are made, people experience, shape, and take on new identities. These processes, then, take place in the context of evolving practice. Wenger, McDermott, & Snyder (2002) identified the possible stages of the development of a CoP which is detailed in the diagram below (see Figure 2).

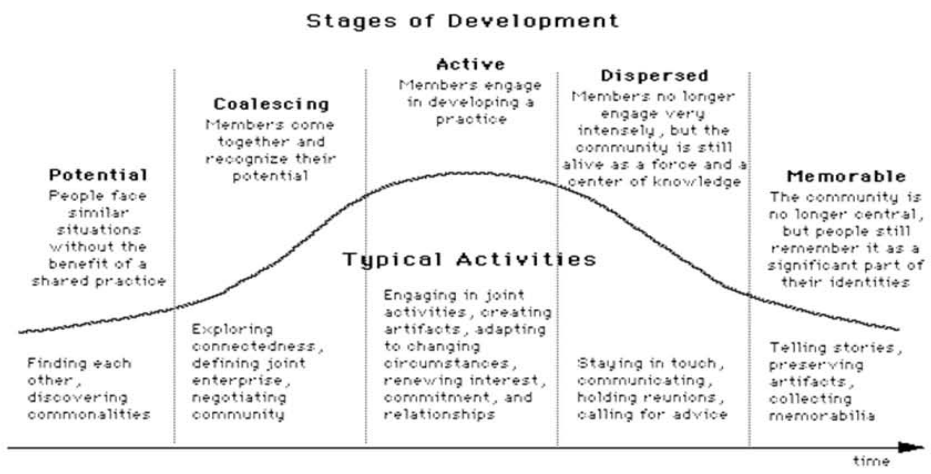


Figure 2. Wenger Communities of Practice Stages of Development
Source: Wenger, McDermott, & Snyder, 2002, p.69

Hart (1992) created the *ladder of participation* for analyzing or describing the degree of participatory engagement of youth. The '*ladder'* like the stages in Figure 2, provide a mechanism for describing the progressive degrees that are involved in participating.

What distinguishes a community of practice from other groups or communities? Wenger (2006) identified three elements as crucial in making the distinction: domain, community, and practice.

The domain. A community of practice is something more than a club of friends or a network of connections between people. "It has an identity defined by a shared domain of interest. Membership therefore implies a commitment to the domain, and therefore a shared competence that distinguishes members from other people" (p.1).

The community. "In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. They build relationships that enable them to learn from each other" (p.2).

The practice. "Members of a community of practice are practitioners. They develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems—in short a shared practice. This takes time and sustained interaction" (p.2).

Time and sustained interaction can be difficult to achieve, especially in schools, due to competing challenges such as new initiatives and state-level priorities that often shift the priorities within the system. In Kentucky, a recent example is the Race to the Top state funding that imposes new requirements on districts related to educators' professional growth and effectiveness. Improvements are documented using a new statewide data management system that all districts and schools are being asked to use.

The many competing challenges and new initiatives take their toll on professional educators. Wagner (2004) contends that "most of us in education are mediocre at what we do, despite our talents and good intentions, because we have all too few opportunities to observe and be observed by a colleague who knows our content, to discuss *problems of practice* with other colleagues, educational practitioners,—in a word, to be a part of what Etienne Wenger calls *communities of practice"* (p.40). Additionally (and troublingly), Wagner found that a commitment to a lifelong learning culture exists in most, if not all, professional fields, with the exception of education. In fields outside of education, a strong commitment to lifelong learning occurs through involvement with other practitioners in communities of practice.

Wagner (2002) outlines barriers in education that prevent teachers from developing a community of practice (CoP) as a mechanism for continual learning about their craft and improving teaching practice. One such barrier is the fact that, traditionally, many people pursue teaching as a career because of the autonomy and security (in the form of tenure and teacher unions) it provides. Wagner indicates that CoPs can be as necessary in education as they are in other professions as a mechanism for continuing to hone the teaching craft. However, Wagner says that many educators experience a lack of opportunities and the expectation that we, as an education organization of professionals, continue to study, reflect, practice, and apply that learning to inform teaching practice. This type of ongoing learning is essential to the profession, especially as standards continue to evolve and the knowledge of how students learn becomes more refined, support mechanisms, like CoPs, can play a pivotal role as the mechanisms for this continued professional learning.

CoPs have the potential for changing the status quo and for learning to occur that can be a "personally transformative experience" (Wenger, 1998, p.6). A community of practice provides a mechanism and place for professionals to share "problems of practice" and receive support from others who share similar interests, expertise, and strong relationships with one another. However, it is important to be aware that although CoPs have many advantages, they are not completely void of problems, examples of which can include becoming prone to group thinking, wanting to keep knowledge to themselves and not wanting to share beyond the group, and restricting membership (Wenger, McDermott, & Snyder, 2002).

Infrastructure Elements

Building on Wenger's research, Wideen's (1992) work also supports the notion of a community of practice as a powerful vehicle for bringing about change in practice and describes a CoP as a place where people learn, become inspired, and find their identity within the group. However, for change to occur Wideen found that certain foundational elements need to exist within the group setting. These elements include certain norms, beliefs, expectations, and support, such as an ethos that allows for risk-taking and for slower-paced implementation. Barth (1990) concurs that support is a necessary social component of change and that those working in a professional group should be provided with a built-in support system and someone to talk to about their learning and practice, in order to improve and sustain the improvement.

Professional Educators and Communities of Practice

Educational researcher Michael Fullan (1991) argues that significant change in teaching practice consists of changes in beliefs, teaching style, and materials, which can occur only through a process of personal development in a social context. However, Wagner (2004) illustrates why so little of this happens in education, even though the community of practice research is promising for the field.

> In many ways, teaching and leadership in schools and districts are still more like 19th-century 'handicrafts'—skills that you learn on your own and practice all alone for most of your career—than a real profession. And as with other handicrafts, like weaving or pottery, how skillful you become at teaching may be more a matter of having an innate 'gift' than learning how to improve. Some craftsmen are, indeed, artists, but many are not (p.41).

Wagner (2004) contends that if educators are to improve, they need to be part of a professional community of practice. Brown and Duguid (2001) argue that communities of practice offer the ideal level of analysis for looking at learning, knowledge, and work identity formation, and that strategic coordination or networking of communities may improve knowledge within an organization. Saint-Onge and Wallace (2003) approach CoPs as vehicles for increasing intellectual capital and for improving individual practice and organizational performance. The authors also propose that CoPs with a strategic purpose help to create an organization's competitive advantage. According to these authors, "communities of practice may be the most significant, tangible example of knowledge management at work in an organization" (p.50).

Communities of Practice verses Professional Learning Communities

A lack of clarity exists as to how professional learning communities (PLCs) and communities of practice (CoP) are defined and operationalized (Voulalas & Sharpe, 2005), resulting in the two terms often being used interchangeably despite their inherent differences. Articulating the differences in these professional development approaches helped clarify the focus of this study, which is on professional change within a CoP.

Blankenship and Ruona (2007) compared models of professional learning communities and communities of practice and explored the knowledge and sharing within both frameworks. The researchers found that "not only are the two concepts distinctly different, but also the models within each concept vary in terms of membership, leadership, and knowledge sharing" (p.8). The PLC model draws from learning organizational theory (Senge, 1990), in contrast to the CoP model that draws from social learning theory. Table 2 summarizes the characteristics of both a PLC and a CoP model

using DuFour and Eaker's work on professional learning communities and Wenger's research on communities of practice. The table also illustrates the differences between the two approaches.

Table 2.

Comparison of Characteristics of a Professional Learning Community and Community of Practice

Moc	Theory Ba	Membership	Leadership	Organizational Cl	Knowledge Sha
Dufour & (PLCs)	Learning Organization	Membership is a forgc conclusion by virtue o as a faculty member; t are assigned to a collaborative team to v on substantive school	Principal; shares de making; provides st with information ar training; model beh congruent with visi values; results orier	Shared mission, vis and values drive the collaboration is key innovation, experimentation an focus on results are essential elements	Discussion is limite team members colla but how teams crea knowledge and shar with the whole organization is not discussed at length
Wenger (	Social Lear	Participation is often voluntary; membershi either be self-selected assigned by the organi based on expertise or p for a topic	Distributed; leaders comes from both fc and informal leader within and outside t community	Organization value innovation and kno sharing	Occurs mainly with community; howev exchange across an community bounda occurs when appro

Source: Blankenship and Ruona, 2007, p.4

Professional learning communities often focus on organizational or whole school improvement by studying issues that affect the entire system. The building principal usually plays a role in establishing and setting the goals and monitoring the work of the PLC. Personnel involvement in this type of community is mandatory. In contrast, communities of practice address the need for alignment to the organization strategy, but they are focused more on improvement of practice and participation is voluntary. However, CoPs may still not work out as designed. Indeed, Mittendorff, Geijsel, Hoeve, de Laat, & Nieuwenhuis, (2006) conclude that CoPs may not be the best avenue for

improving organizational learning. Mittendorff et al. also note that even groups that function as a CoP may sometimes be resistant to change and may not be open to sharing their collective learning outside of the community.

PLCs in general emphasize the role of the leader, while the CoP literature downplays that role in favor of more organic leadership, both formal and informal, often arising from within the community. Also, CoPs tend to offer more insight into the value of social and professional networks as they relate to change knowledge creation and dissemination as well as the informal learning process of growth that occurs in and among individuals—subjects that this study seeks to explore and that seem to be missing from the literature.

In this study, the case subject volunteers to participate in the multi-year Appalachian Teacher Partner Project. The communities of practice framework provided a structure through which the case subject's participation within a structured community of practice can be analyzed.

Change in Schools

The structure of schools has changed little from when they were created more than 150 years ago. In these early schools, teachers were the workers and students were the products. During the daily operation of the school, teachers used different instructional standards for each age group of students, established specific timeframes for students to learn the material, and used tests to determine the degree to which students gained the prescribed knowledge (Callahan, 1962). Although society has changed drastically since the industrial age, schools remain largely embedded with the ideas and practices from that time—a situation that many researchers believe is detrimental to

students, given the skills that have been identified for students to leave their K-12 schooling, career and college ready.

For example, in Tony Wagner's book, *The Global Achievement Gap* (2008), he identifies survival skills that students need to possess for work, learning, and citizenship in the 21st century. His overall finding was that teachers must orchestrate their classroom so students are taught how to think. To accomplish this goal, teachers will need to stay current in their knowledge of their discipline. This expertise is essential if teachers are to create an environment where students experience instruction that requires them to use strategic habits of mind—now embedded in the Kentucky Core Academic Mathematics Standards—for example, to persevere, communicate, and problem solve. Wagner states that communities of practice can serve as mechanisms for educators to provide the support needed for successful student learning that promotes the strategic habits of mind needed to be career and college ready.

The support for communities of practice for educational organizations is evident in Fullan's research. Fullan (1993) writes that people learn new patterns of behavior primarily through their interaction with others. This implies that shared meaning and shared cognition, or "interactive professionalism" as Fullan (1991) labeled it, play significant roles in the change process. "Since interaction with others influences behavior, relationships with other teachers appear to be a critical variable in changing practice. Change also involves practicing and learning to do something new, and interaction is the primary basis for social learning" (p.77).

This study describes participation negotiated through involvement in an *intellectual partnership* that are *more* than just exchanging strategies, but an authentic

intellectual give and take where all parties engage AND benefit. The partnership resulted in the teacher negotiating transformative participation, which affected her professionally. I also describe how the teacher's participation affected her classroom practice and student learning in an AP mathematics classroom.

Contingency Theory and Resistance. Although the actions of an individual can be key to changing classroom practice, school culture can limit or enhance this change. Culture, according to Fullan (1999), is a deep pattern of perspectives and behaviors within an organization. Chenoweth and Everhart (2002) suggest that it is critical to examine the elements (e.g., leadership, organizational history, teacher expertise) that make up a school's culture because they could affect successful implementation of improvement efforts. Elements of a school's culture can pose an even greater challenge in Appalachia where many educators, administrators, and community members have learned how to "do school" the way they experienced it in the same community as a student and where now, as a teacher or leader, they are resistant to social change in general. According to Lortie (1975), a teacher's vision of what is possible is informed by their experience and exposure, and past experience exerts powerful influences that can be limiting and energizing at the same time.

Culture

The culture in a school, can be referred to as the "way we do things around here," can prescribe how teachers behave in order to be accepted (Rossman, Corbett, & Firestone, 1988; Hargreaves, 1994). Hargreaves identified several ways the school culture can affect teaching and learning. In particular, he referenced some ongoing

challenges for schools, such as isolation, poverty, politics and culture, and rural control, that can affect the *culture of teaching.*

> In general, these various cultures provide a context in which particular strategies of teaching are developed, sustained and preferred over time. In this sense, *cultures of teaching* comprise beliefs, values, habits and assumed ways of doing things among communities of teachers who have had to deal with similar demands and constraints over many years. Culture carries the community's historically generated and collectively shared solutions to its new and inexperienced membership. It forms a framework for occupational learning. (p.165)

Conceptual Framework

The conceptual framework for the study is outlined in Figure 3 using Gowin's Vee heuristic (Novak & Gowin, 1984). The figure provides a means by which to focus, reflect, and redirect the course of research when necessary. It also identifies elements that contribute to the development of meaning and knowledge in research (Novak, 1998).

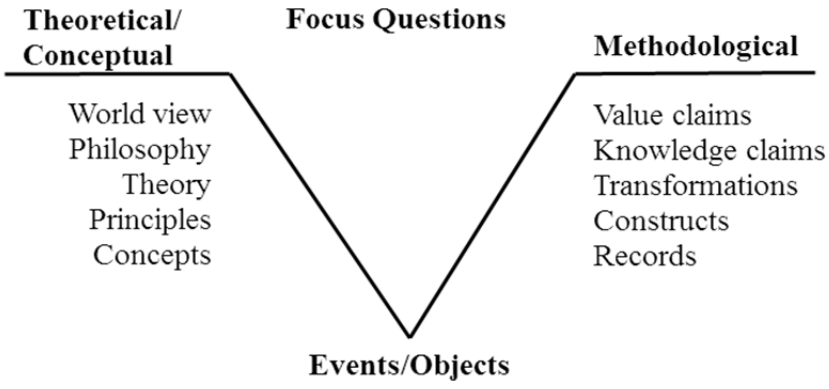


Figure 3. Gowin's Vee diagram

Gowin's Vee helps guide research by connecting theory and practice. The center of the Vee represents the research questions and includes any sub-questions that may be answered by the research. The lower part depicts the events and objects studied to answer the research questions. The left side represents the conceptual component specifying the relevant concepts, principles, theories, and worldview influencing the study. The right side of the Vee is the methodological part of the research. It identifies the records and transformations that are constructed and inferred to produce the value and knowledge claims of the study. The knowledge for the Vee was acquired through library research, Internet research, and coursework.

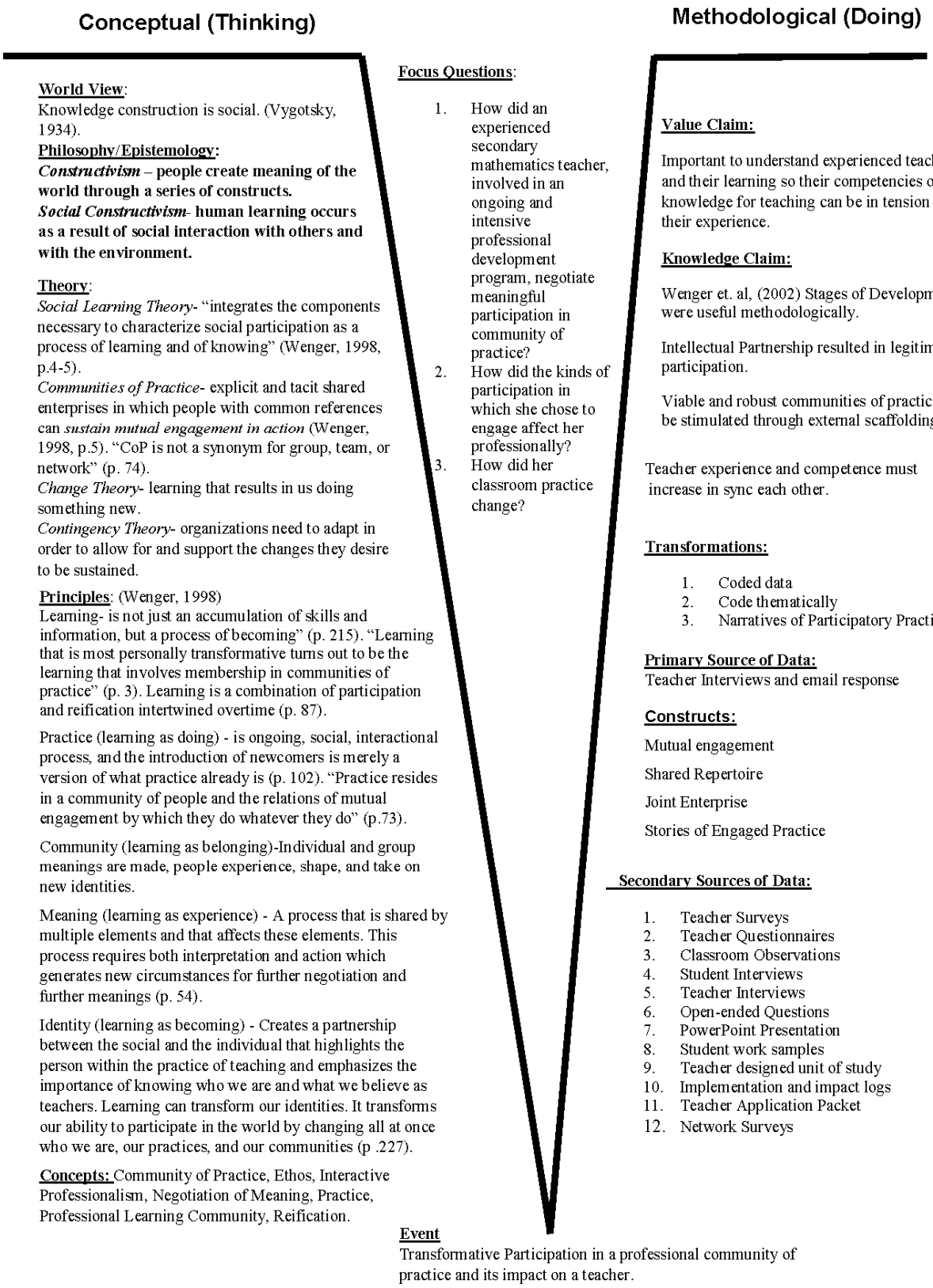


Figure 4. Study Vee

Relevant Literature

Teacher Quality: What Matters?

The teacher appears to be the single most important factor in determining student achievement (NCTAF, 1996; Darling-Hammond, 2000). Therefore, Elmore (2002) and other educational reform researchers view improvement in teacher qualifications as a key component of current efforts toward educational improvement and systemic reform. Presumably, teacher participation in high-quality professional learning experiences plays a pivotal role in improving teacher quality. However, research has repeatedly shown that mandatory, formal professional learning seminars and institutes fail to meet the needs of teachers (Huberman, 1995; Little, 1999; Wei, et al., 2009) and that most professional learning experiences for teachers do not result in the intended changes in classroom practice. Not surprisingly, without buy-in from teachers and their willingness to bring about change, results will be limited (Darling-Hammond, 1997; Fullan, Hill, & Crevola, 2006). Hord, et al. (1987) found that support in the form of monitoring is also an important consideration when working to improve teacher quality, stating that

> After teachers start to use a new program or practice, monitoring activity can be influential in reminding teachers that their attention is required for the program. It helps teachers recognize that the improvement project is a priority, that a commitment has been made to it, and that somebody cares about them, about the change, and how it is occurring in classrooms. Monitoring is also a natural complement to consultation/reinforcement in that it provides valuable data about how individuals are doing and what their assistance needs might be" (p. 77).

In addition, highly effective teachers report that the school principal plays an important role in their ability to orchestrate an effective learning environment (Fullan, 2002; Fuller, Wood, Rapoport, & Dornbusch, 1982; Maeroff, 1993). Teachers describe effective principals as being understanding and supportive of informed risk-taking in the classroom. Teachers under the supervision of such a principal feel a sense of safety and freedom from reprimand if they try to implement new ideas, tools, and strategies to meet the needs of their students. These teachers feel safe taking risks because their environment supports those who implement strategies that promote student learning. Lieberman and Miller (1984) concur, stating that teachers who view their principals as critical or punishing will not take risks.

Thus, based on the research above, it is clear that improving teacher quality is a complex endeavor with multiple dimensions, including teacher roles, teacher buy-in, implementation support and accountability, external expectations of performance, and an understanding of how teachers experience the professional development associated with educational reform and school improvement efforts. In fact, Hattie (2009) states that "the current mantra, that teachers make the difference, is misleading. Not all teachers are effective, not all teachers are experts, and not all teachers have a powerful effect on student learning" (p.108). Hattie contends that researchers must examine the ways in which teachers differ in their influence on student achievement and the dimensions of their practice which affect that achievement.

Adaptive Experts and Lifelong Learners

The vision guiding educational reform should be improved teaching and learning. Franke, Carpenter, Levi, and Fennema (2001) indicate that generative knowledge is

developed when teachers, “perceive themselves as learners, creating their own understandings about the development of student thinking” (p.685).

The publication “Preparing Teachers for a Changing World” uses the ideas about learning shared by social constructivists to explain the role that culture and human interaction play in the developmental processes of teachers as lifelong learners (National Academy of Education, 2005). They contend that becoming a *lifelong learner* as a teacher is complex and involved. Teachers who are truly lifelong learners rethink their practice, which often requires them to abandon old routines and adopt new ones. Therefore, effective teachers need to adopt the mindset “that being a professional involves not simply ‘knowing the answers’ but also having the skills and will to work with others in evaluating their own performances and searching for new answers when needed, both at the classroom level and school level” (p.365). “True adaptive expertise for a teaching professional involves a deep appreciation of the value of actively seeking feedback from many sources in order to make the best decisions for children and to continue to learn throughout one’s life” (p.366).

In summary, the researchers state that teacher engagement in an intellectual CoP can be important if teachers are to become lifelong learners who continually seek to strengthen their classroom teaching practice and improve student learning. They also contend that by participating in ongoing communities composed of their colleagues, teachers build knowledge that assists them with engineering effective learning experiences.

According to Barth (1990), teachers derive additional benefits from working in groups, including developing a built-in support system, having someone to talk about

their teaching and learning, and having someone with whom they can empathize and celebrate successes. Barth also notes that certain risks are associated with collegiality because opening oneself to observation and communication means giving up something without knowing in advance what it may be. Echoing the research of Huberman and Little in the 1990s, Rock and Wilson (2005) showed that while active learning and discussions with colleagues supported teacher reflection on their own practice and students' learning, *mandating* practical inquiry or making collaborative work a requirement is likely not to be as effective as a mechanism to change classroom practice.

Further, unless fundamental changes occur in the way people think, interact, and explore new ideas, then reorganizing fads and strategies will produce minimal sustainable change in the classroom (Sarason, 1990). Wagner (2004) suggests that most professionals, such as doctors and clinicians, have mechanisms in place that allow them to analyze data and work together to solve problems of practice—but this is often not the norm in many educational settings.

Professional Learning and Transfer to the Classroom

Hattie and Jaeger (2006) identified five dimensions that distinguish an expert teacher from an experienced teacher. "Expert teachers have high levels of knowledge and understanding of the subjects that they teach, can guide learning to desirable surface and deep outcomes, can successfully monitor learning and provide feedback that assist students to progress, can attend to more attitudinal attributes of learning (especially developing self-efficacy and mastery motivation), and can provide defensible evidence of positive impacts of the teaching on student learning" (p.28).

Studies indicate that features of professional development affect teacher practice (Desimone, 2009; Elmore, 2002; Hawley & Valli, 1999; Sykes, 1999). As was expected, researchers have found that no single formula exists for designing and delivering professional development; however, certain features can affect the likelihood that knowledge transfer will occur between the professional learning environment and the classroom. For example, according to Desimone et al. (2009), for professional development, or professional learning as it is often termed, to have an impact, it must be designed to meet the needs of each individual situation. The professional development design plan should focus on and involve teachers because they are critical to implementing the changes in classroom practice demanded by reform visions (Fullan & Miles, 1992; Spillane, 1999), as in this case of an AP mathematics teacher of rural students. The tension between the vision of a successful mathematics classroom and the current reality drives the desire to change and gives meaning to the task of implementing or refining classroom practice (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 1998).

Hargreaves and Fullan (1992) add that to improve teacher practice, teachers need the knowledge and skill development that will increase their ability to provide opportunities for the children to learn. Although knowledge and skills-based approaches can be criticized as top-down mandates that ignore the teachers' experience and voice, they can be beneficial if their use is limited to focusing on methods that are understandable and usable by teachers in the classroom, as well as presented with ongoing administrative support.

Grossman and colleagues (2001) pointed out that without ongoing learning in subject area content, many teachers rely on courses in their undergraduate major area of

study for their entire career (p.994). Additionally, Garet, Porter, Desmimone, & Birmanet, & Yoon (2001) found that professional development is more effective and appears to have an effect on a teacher's knowledge and skills when it is content specific, provides opportunities for active learning, and is easily integrated to what teachers regularly do in their classrooms. Various educational experts have also determined that guidance, support, and feedback are essential components for changing teacher practice (Ball & Cohen, 1999; Hong, 1996; Putnam & Borko, 1997; Wilson & Berne, 1999).

Kotter (1996) asserts that schools are often complacent because teachers lack feedback from someone who also knows their content and has a vision of effective instruction. Kotter also states that dedicated time should exist for teachers to learn, plan, reflect, provide feedback to each other, and to continue to develop their skills over time. Fullan (1991) states that "research on implementation has demonstrated beyond a shadow of a doubt that the process of sustained interaction and staff development are crucial regardless of what the change is concerned with. The more complex the change, the more interaction is required during implementation" (p.86).

A range of agencies and studies have tried to quantify the professionally development hours of sustained interaction that is typically needed in order for a phenomenon to be implemented effectively in the classroom. The Council of State School Officers in 2008 published results of a study that examined mathematics and science professional development programs funded by the National Science Foundation (NSF) across 14 states to determine when a change in teaching practice and student learning occurred. The study found that significant effects result after 50 hours or more of sustained interaction and staff development time. Further, in a review of nine studies,

Yoon, Duncan, Lee, Scarloss, and Shapley (2007) found that professional development lasting 14 or fewer hours showed no effect on student learning, whereas programs offering more than 14 hours of sustained and focused teacher learning opportunities showed significant positive effects. The largest effects were found for programs offering between 30 and 100 hours spread out over a minimum of 6 to 12 months.

This study examines the various sustained interactions and experiences, including the number of hours that the case subject, Mrs. Jennings, engaged in the experiences during a multi-year project. Further, this study describes how dimensions of her participation, including sustained interaction, informed her practice and student learning.

The Appalachian Teacher Partner Project: Context for the Study

In this section, I describe the five year project funded by the National Science Foundation (NSF) in which the case teacher participated.

In the fall of 2008, the *Appalachian Mathematics and Science Partnership* (AMSP) received supplemental funding from the National Science Foundation to implement an *Appalachian Teacher Partner Project* (ATPP). The goal of the ATPP was to develop 18 teacher leaders from participating Appalachian districts across three states. The project began in the spring of 2009.

The participants consisted of 18 teachers, 15 who taught secondary mathematics (9 from Kentucky; 3 from Tennessee; 3 from Virginia). The other three participants taught secondary science in Kentucky. These participants referred to themselves as Appalachian Teacher Partners or ATPs, a name they came up with during one of the project meetings. Originally scheduled for completion in June 2011, the ATPP has been

continued under no-cost extensions, with the last training activity and final data collection occurring in December 2013.

Four teacher leaders (known as Regional Teacher Partners), from a previously funded NSF project similar to the ATPP, mentored and supported the 18 ATPs during their project activities. These teacher leaders had an intimate knowledge of the distinctive role that the ATPs would be expected to play within the local school and district systems because they had served in a similar role for eight years. They had also experienced some of the same training in which the ATPs would participate.

Participants received $10,000 each year for their participation in the first two-years of the project. The anticipated time requirement for each participant was expected to average 6 weeks for the first two years. This generous stipend was a budget requirement from the project sponsor as part of this specific funding opportunity. However, this compensation also opened the program up to the critique of replicability and scale-up (even a comment noted by the program evaluator). One purpose of this case study is to provide an in-depth analysis of participation so that future programs might focus on the experiences and competencies scaffolded by the CoP *design* and not related to the financial support provided by this specific NSF funding opportunity.

Project Implementation. The Appalachian Teacher Partner Project began in October 2008 with development and dissemination of a request for applications for teachers to participate, along with marketing of the ATPP to teachers and district administrators (e.g., superintendents and instructional supervisors) who participated in the Appalachian Math and Science Partnership. An important part of the application process was the requirement of a Professional Development Plan created with input from

district and school leadership. The plans explained the district's intentions to utilize the evolving expertise of their Appalachian Teacher Partner (ATP) in concrete ways to improve mathematics and science content knowledge, instructional techniques, and assessment practices at the local and regional level.

The ATPP project coordinators, consisting of a project director and Regional Teacher Partners, were aware that the success of the program for individual teachers depended largely on administrative support and a commitment to sufficient release time from classroom responsibilities to meet both learning and performance objectives. Administrative support included payment for substitute teachers so that the ATP could participate in all project activities. It also included a willingness on the part of the school and district administration to support the ATP in leading school, district, and regional professional development and the district's support of plans that met the identified learning needs of teachers. A minimum threshold of release time for the ATP included at least eleven days per academic year and five days in the summer. The time commitment supported the ATPs' participation in the three levels of formal activity—level one, the structured community of practice; level two, participation with education experts; and level three participation with mentors, including Regional Teacher Partners and Institution of Higher Education Mentors—in which teachers were networked into the broader professional community of mathematics educators described below.

Structured Community of Practice. The development of the Appalachian Teacher Partner Project was informed by the community of practice (CoP) research (Lave & Wenger, 1991; Wenger, 2006), allowing for a design to emerge based on the needs of the participants and the breadth and depth of intended growth experiences. Wenger's

research on communities of practice offers insight into the informal learning process of growth that occurs in and among individuals over time. This research serves as a lens through which I detail Jennings' participation in the ATPP, the project's impact on her professionally, and the ways in which her participation changed her teaching practice. As previously defined, a community of practice addresses the need for alignment with the organization strategy, but it focuses on improving practice through voluntary participation.

The ATPP was designed to provide opportunities and experiences that would allow for a community of practice to emerge organically. The project leadership saw such a community as vital in developing expertise and support for the participants as they worked to change their practice. The CoP was viewed as essential to the project and a way to develop a sustained and ongoing support system that the ATPs could access and interact with over time.

Contributions to Effective Practice: Formative Assessment and Differentiation. A pedagogical focus of the Appalachian Teacher Partners Project (ATPP) was effective classroom-level assessment as it relates to classroom practice. In their 1998 publication "Inside the Black Box," Paul Black and Dylan Wiliam brought worldwide attention to the topic of accurate and effectively used classroom assessment.

Data from a previous study by AMSP that surveyed teachers and leaders about professional learning needs identified formative assessment and differentiation. The AMSP survey findings, when combined with those of other studies, (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Cobb, Wood, Yacke, Nicholls, Wheatley, Trigatti, & Perlwitz, 1991), provide a compelling argument that helping teachers identify,

learn, and implement effective formative assessment practices and processes can significantly improve teacher practice. These data can also help teachers better understand the thought processes of their students and use that information to determine next steps for instruction.

Work with Experts. All Appalachian Teacher Partners, accompanied by the project director, higher education faculty, or Regional Teacher Partner, attended institutes on assessment and differentiation and worked with national experts known for their expertise in these areas. The experiences with these experts continued throughout the project. Additionally, the participants met with the Regional Teacher Partners and project director for six hours one day a month, for six to seven months each academic year and approximately five days each summer during each year of the project. The meetings focused on sharing content as it related to curriculum, instruction, and assessment, including the use of data to make instructional and program decisions. More specifically, the meetings helped participants conceptualize and dissect complex instructional standards into the basic learning targets that make up the standard. They also focused on selecting or developing classroom assessments, providing feedback effective feedback to their students, learning how to engage with students, and developing metacognition strategies. A leadership development component was also included as part of the meetings.

Project Mentors. Over the course of the ATPP, the Appalachian Teacher Partners, also known as "teacher mentors" participated in several meetings and long-term projects, in addition to attending seminars and working with their Regional Teacher Partners (RTPs) and others to enhance their knowledge base and, ultimately, improve

their teaching practice. RTPs observed the participants in their classrooms annually, and the participants worked with the RTPs and their fellow participants both formally and informally, providing and receiving feedback. In addition, institution of higher education (IHE) mentors worked with the Appalachian Teacher Partners in small groups on a project based on a phenomenon of mutual interest.

Regional Teacher Partners as Mentors. The Regional Teacher Partners (RTPs) visited each ATP's classroom four times, observing their teaching of multiple classes and levels each visit. The purpose of the initial observation was to collect baseline data about the instruction and classroom. Teacher mentors and ATPs had a preliminary discussion prior to each visit about what the ATP had been working on, if the ATP wanted the RTP to watch for use of certain strategies or interactions during the observation, and what the RTP should expect to see students doing the day of the visit. The three subsequent visits included time for the RTP to debrief the ATP after the classroom lesson, reflecting on what the teacher mentor observed and discussing what went well and what might have improved the learning experience.

Additional Mentoring Opportunity. ATPP participants received additional mentoring from professors of institutions of higher education (IHE mentors). These mentors worked with their assigned Appalachian Teacher Partners (ATPs) on a project that was of mutual interest. Six IHE faculty from STEM disciplines and/or math or science education were selected as mentors. Each mentor worked with a team of two to four ATPs. IHE mentors sites were established at six geographic locations across the three states so that the ATPs could meet with their IHE mentor for a total of 66 hours over two consecutive years. The goal was for the location not to be a barrier for the

project that the team decided to pursue. Additionally, the hope was that relationships would be developed that would allow for collaboration between the team after the project ended. After the final team meeting, an end of mentoring celebration and sharing session was held that provided time for each team to share their project and the learning that came out of the sessions with the other ATPs.

The ATPs attended one of several national institutes with their IHE mentor that focused on mathematics or science and teaching and learning. Selection of which institute to attend was based primarily on the focus of the team project. The team attended the sessions together so they could immediately discuss how the material being presented could inform or support the team project. Among some of the institutes attended were the Assessment Training Institute Leading Professional Development with Classroom Assessment for Student Learning; the National Council for Teachers of Mathematics Sponsored Institutes; and the Association for Supervision and Curriculum Development Institutes on Differentiation and Teaching and Learning.

Structured and Unstructured Opportunities for Participation. Central to the Appalachian Teacher Partner Project design were the regular opportunities—both structured and unstructured—for participants to collaborate, network, reflect on problems of practice, celebrate successes and help those who were struggling, and focus on practicing new tools and strategies as a learner and teacher. The participants provided each other feedback and also received feedback from Regional Teacher Partners and the project director who served as the project facilitators. The monthly meetings, along with an annual five-day summer event, attendance at conferences, and other experiences to support ATP development, provided for a total of approximately 126 hours per year in

which ATPs had the opportunity to work together and support each other in a variety of project activities, focusing on effective teaching and learning. The specific focus of learning experiences that the ATPs were involved in emerged organically over time as the ATPs provided specific input on what they needed to further improve. The project team used emerging formative data from the project evaluation to make adjustments to meet the evolving learning needs of the teachers.

The Appalachian Teacher Partner Project professional development model reflects numerous characteristics reflected in the literature on effective professional learning. According to the data, the following aspects of the project design assisted Jennings with negotiating her participation in a community of practice:

- Frequency and duration of sessions to enable to engage deeply with the targeted learning.
- Sustained development and support period (three years, extended to four) to allow new learning to be translated into initial steps and more polished implementation.
- Use of professional development resources produced and tested by respected developers.
- Active engagement during professional sessions, fostering collaborative working and learning on topics meaningful to the ATPs and relevant to their practice.
- Opportunity to interact and work closely with experts, including higher education mentors and nationally recognized consultants.

- In-depth use of quality reference and resource materials to provide a foundation from the literature, to serve as prompts for thinking and discussion, and to build a culture of ongoing professional learning.
- Balance of work driven by the project with applications tailored to participants' individual backgrounds and interests.
- Opportunity to practice new learning in their own classrooms, receive support and feedback from project staff, and reconvene to process their experiences with their fellow ATPs.

The learning objectives used to design the experiences of the project are outlined below.

- Enrich and contextualize content knowledge in science and/or mathematics through the integration of focused study aligned with national standards.
- Increase knowledge of current research and resources that support student learning of mathematics and science content in K-12 classrooms.
- Increase knowledge of both formative and summative strategies, utilizing both traditional and authentic methods for assessing student learning.
- Increase leadership, communication, and human resource skills to work effectively with the social and political dynamics that impact teacher effectiveness within districts.

Characteristics of an Advanced Placement (AP) Teacher

The case subject, Danielle Jennings, taught Advanced Placement (AP) courses during the time she was involved in the Appalachian Teacher Partner Project. Previous research has not focused specifically on how an experienced teacher of AP mathematics courses negotiates her participation within a community of practice and how the interaction during the CoP experiences affects her professionally, including her classroom practice. However, a study by Burton et al. (2002) examined the role of teachers in AP courses, specifically looking at teachers who were successful in enrolling and teaching minority students including students of poverty. The study suggested that an AP teacher first needs to embody the characteristics research has identified as successful for teaching underserved students. In addition to strong content knowledge and professional development, these characteristics include the following:

- High expectations for all students.
- A deep understanding of the characteristics of all students.
- An awareness of both the background and cultural resources of students.
- The prevailing culture of the school and the classroom.
- Using a broad array of teaching strategies and tools.
- An ability to engage students in meaningful learning tasks.
- An ability to personalize and adapt instruction to the needs of students.
- An ability to foster cooperation and communication between the teacher, students, and the parents.

Building on this research, this study allows for an in-depth description of how a high school AP mathematics teacher, involved in an ongoing and multifaceted

professional development project, participates in a structured community of practice. The study is situated in a unique setting, a classroom in a rural Appalachian high school with a student population of 854 and a high poverty level of 71 percent. It is a hope of this researcher that the rich qualitative data (see data chart in Chapter 3) adds to our understanding of essential experiences for helping veteran teachers continue to improve their practice.

Professional Practice and Rural Education

Improving the professional practice of teachers require actions that address the unique context and conditions of rural schools (Chalker, 1999; DeYoung, 1991; Harmon, 2003; Howley & Harmon, 2000). The isolation of rural schools can create challenges in providing teachers an opportunity to explore problems of practice in communities with others who do similar work. In urban and suburban school systems with large student populations, it is necessary to have several teachers for each grade or each subject. This is in contrast to rural school districts with smaller populations where classes are often smaller and fewer teachers are needed.

Research suggests that many teachers in rural districts grew up and went to school in the district in which they now teach (Collins, 1999) and are less likely to leave because they have family ties to the community (Bornfield, Hall, Hall, & Hoover, 1997). Choosing this path, however, may lead to isolation, which can create a limited vision of how learning can be engineered. It also makes collaboration with other teachers difficult.

Challenges for Rural Schools

Instruction in rural schools is often difficult to change because these schools must overcome a number of challenges unique to the rural culture.

First, rural districts have to contend with challenges related to their size and economic status that can inhibit their reform and improvement efforts and make change difficult. According to Meier & Edington (1983), one major challenge in many rural districts is the availability of content-specific professional development. The researchers found that it is often not cost effective for districts to provide this type of training locally. For example, many rural districts have only one high school and one chemistry teacher. Therefore, it is not cost effective for these districts to provide content-specific professional development in chemistry, or even high school science, because of the small number of science teachers on staff. Consequently, rural teachers often need to travel great distances to receive advanced degrees or in-service training that meets their continued professional learning needs (Meier & Edington, 1983). Ultimately, if lifelong learning of teachers is not valued, the economic health of rural school systems can and will likely deteriorate.

Second, rural communities tend to prioritize athletics and other extracurricular activities over instruction (Peshkin, 1978). In DeYoung's (1995) study, the superintendent in one school district was shocked when after three schools were consolidated, the type of questions parents asked primarily related to the athletic program and not the instructional program.

Athletics and other extracurricular activities become a mechanism for community involvement and entertainment in rural places where few other options exist

(Hollingshead, 1975; Peshkin, 1978). Because most rural communities do not have a movie theater or many restaurants in town, residents look to the church and school for entertainment. “A winning football team or a shorter bus ride for students would be more realistic than community support for locally-derived standards. The standards of excellence vary among schools and cause local school administrators and teachers to be in constant debate about how to meet state goals while simultaneously addressing local concerns, traditions and values” (Harmon & Seal, 1995).

Third, rural communities and schools tend to believe that the “3Rs”—reading, writing, and arithmetic—are essential components of a good education. According to a study by the Educational Research Service (1992), the focus on the 3Rs stems from what the community values as important and can influence how instructional time is utilized. The study suggests, however, that these three components may not provide students all of the tools they need to succeed. “Students extensively exposed to instruction emphasizing meaning and understanding perform better on tests of advanced academic skills at the end of the school year, even after initial differences in student achievement and poverty level are taken into account” (ERS, p. iii). Additionally, “recent research and a growing body of evidence from demonstration programs suggest that academically challenged learning experiences can benefit the children of poverty, who are at the greatest risk of academic failure” (ERS, p.5).

Finally, residents of rural areas are more likely to be poor and to have parents who are less educated than urban parents. Absence of a clear and compelling link between education and economic opportunity can erode the motivation of students. It can also

become an obstacle for schools as they attempt to improve student performance and reduce dropout rates.

Conclusion

The theoretical framework and literature cited provide the conceptual lens for the inquiry and analysis. The methodology described in Chapter Three presents the case method design

and procedures for the study.

Chapter Three

METHODOLOGY

Research Design

The study is based on the assumption that it is possible to describe how teachers apply new learning to inform their classroom practice and promote student learning. The goal of the study is to examine how an experienced mathematics participates in a community of practice, and how her approach to planning and orchestrating classroom instruction changed through her participation in a National Science Foundation (NSF)-sponsored project—the Appalachian Teacher Partner Project (ATPP).

The study design is a descriptive, holistic, single case study (Yin, 2003b) through which a detailed holistic account of the phenomenon under study is provided. This particular study is of interest and worthy of descriptive analysis because the subject is a veteran teacher with 20 years of classroom experience, who transformed her practice through participation in a professional community of practice. Experienced teachers' practices are often entrenched and resistant to changing practice. Moreover, the case is situated in rural Appalachia, where opportunity for professional growth has numerous social and economic challenges for educators.

To reiterate the main research questions for the study, these are: (1) How did an experienced secondary mathematics teacher, involved in an ongoing and dual-faceted professional development project, negotiate meaningful participation in a community of practice? (2) How did the kinds of participation in which she chose to engage affect her professionally? and (3) How did her classroom practice change?

Underlying the choice of case study methods are the following assumptions: reality is constructed by individuals who interact in their social worlds, meaning is

embedded in individual experiences and is mediated by the researcher's perceptions (Merriam, 1998), and knowledge is both personal and social (Lave and Wenger, 1991; Wenger, 1998).

According to Lave and Wenger, data collection that is focused on social practice theory should include teachers talking about (and within) their practices and experiences; therefore, the data set for this study includes examples of what the teacher said and did throughout the project. It also includes participant and student interviews (video footage), questionnaires, unit planning, student work samples, classroom observer notes, informal conversations, and other relevant documents. The methods of data collection cohered with the theoretical framework of social practice theory and the work of Wenger as well as Lave and Wenger. My goal was to use the data to holistically describe how an experienced teacher negotiates participation in a community of practice, how her participation affects her professionally, as well as how she applies her understanding to transform her classroom practice.

Participant:

The participant in this study, Danielle Jennings, is an experienced mathematics teacher who had 20 years of classroom experience—all in the Appalachian Region of Kentucky—when she began participating in the ATPP project in the spring of 2009. Jennings has a Bachelor of Science in mathematics with a minor in applied statistics, a Master of Arts in mathematics education, and a Rank I in mathematics. She was chosen for participation in the NSF project because she met specific eligibility criteria (see Figure 5).

• Currently hold or be actively seeking a master's degree in mathematics, science, mathematics edu or science education.
• Be currently teaching mathematics and/or science in a high-needs school district.
• Agree to continue teaching in the same school for the duration of the project.
• Have at least five years of teaching experience.
• Commit to three years of active participation in all aspects of the NSF project.
• Provide evidence of district support by way of a written letter of commitment signed by both the and a district level administrator. The letter must provide evidence of the need, outline a plan to u teacher's evolving expertise in math and/or science improvement efforts (specifying concrete commitments for released time per month), and provide a rationale for supporting that particular as a leader.

Figure 5**.** Eligibility Criteria: Criteria for selected candidates in the NSF-funded project, including

the case teacher, are shown below.

A selection panel consisting of individuals actively involved in mathematics and/or science education improvement efforts in central Appalachia reviewed applications, interviewed candidates, and selected 18 teachers (15 math and 3 science) to participate based on the eligibility criteria and the following selection criteria (Figure 6).

• Candidate's record of academic achievement – as judged by the quantity and level of success in c courses related to the content taught by the candidate.
• Candidate's record of professional performance – as judged by student achievement, membership level of activity in professional organizations, involvement in personal growth activities, level of involvement in school and district activities, and level and type of involvement in leadership roles
• District need – as judged by socio-economic factors, poverty levels within the district, and the aca achievement levels of their students in mathematics and science.
• District culture – as judged by information such as the level of commitment that is indicated in of support for the candidate, the amount of turnover in mathematics and science teaching posit the number of new teachers of mathematics and science in the district.
• Potential for impact – as judged by level of commitment to the project and the quality and breadth plan to utilize the expertise of the teacher.

Figure 6. Teacher Selection Criteria

The case study subject had taught 18 of her 20 years in her current district when she applied to participate in the NSF project. Jennings' school administration considered her an effective teacher as evidenced by their letter in support of her application. The district supported Jennings' desire to continue to improve her ability to meet the diverse

needs of students in her rural Appalachian district. Before applying for the project, she had worked to improve her understanding of mathematical content by acquiring 60+ graduate hours of mathematics and mathematics education courses. She had also worked every semester since 1993 as a part-time adjunct professor for a Kentucky university, where she typically taught College Algebra 107 in the fall and Math with Applications 105 in the spring.

During the project, Jennings continued to teach an Advanced Placement (AP) course, during which she worked to refine her practice to include the lessons learned from the NSF project. According to a study by the Thomas B. Fordham Institute (2007), the College Board does not require AP teachers to be specially trained in any way. However, successful implementation of AP curriculum, according to study, depends on the availability of talented, motivated, and well-educated teachers. The study concluded that AP courses do not provide an opportunity for deep learning and are instead a means to an end of college admission and credit. However, some states, districts, and schools still consider AP as the gold standard and are working to infuse more AP courses into their high school curriculum offerings.

Jennings' AP instruction and class is relevant to this study because the state of Kentucky is strongly interested in introducing more AP courses in high schools. A significant portion of the state is rural; therefore, the need for AP teachers who can prepare students for success on the AP exam is high. I describe how Jennings was able to transform the intellectual climate in her classroom, incorporate new tools and strategies into her planning and how those strategies played out in instruction to improve student learning and success on the AP exam.

Selection of Research Subject and Negotiating Access

In the summer of 2013, I asked Jennings if she would be willing to serve as the single subject for my study. I shared with her my research interests and answered her questions. She graciously agreed to participate by allowing me to use data collected by the project evaluator and leadership for my inquiry. She also agreed to provide additional data that would support the study and would member check parts of the data analysis section for accuracy. In addition, Jennings agreed to help me secure permission to speak with eight of her AP students from the class of 2012–2013 who were video interviewed during that same year about their experience in her classroom. I also worked with the publishing company that has rights to the video footage, and they agreed to allow access to the student and teacher interview data for use in my study. Accessing these data involved close interaction with Jennings, and required trust and mutual respect.

Case Study Design: A Descriptive Approach

As Yin (2003b) observes, case study is a design particularly suited to situations in which it is impossible to separate the phenomenon's variables from their context. Yin also suggests that case study has a distinct advantage if the researchers are asking "how" and "why" questions "because such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence" (Yin, 2003a, p.6). The case study examines how a veteran rural teacher participates in a community of practice, how she is impacted professionally because of her participation and how her participation impacts what she does in the classroom.

Yin (2003b) outlined a two-part definition of the case study research method to illuminate it as a comprehensive research strategy. Table 3 illustrates each aspect of Yin's definition and how the study fulfills the characteristics of the case study method.

Table 3.

Case Study Definition Applied to Study

Yin's Definition of a Case Study as a Re Method	Case Study's Application of the Definition
1. A case study is an empirical inquiry th	
"investigates a contemporary phenomeno depth and within its real-life context	The current phenomenon for this case stu the transformative participation of a veter teacher in a professional community of pr and the impact the participation has on he professionally and on her classroom pract an AP teacher in the real-life context of th teacher's daily work.
2. The case study inquiry	
"copes with the technically distinctive sit in which there will be many more variabl interest than data points…	Multiple variables include the case subjec interactions within and outside the CoP; h perceptions about the changes; student perceptions of classroom culture and supp for learning.
"relies on multiple sources of evidence, w data needing to converge in a triangulatin fashion…	Sources of evidence is comprised primari data collected by the project and project evaluation team including: the project application materials, completed observat protocol of classroom instruction with ob notes, questionnaires, surveys, sociogram developed from network survey data, stud work samples, teacher and student intervi and other artifacts (e.g., unit of study, assessments).
"benefits from the prior development of theoretical propositions to guide data coll and analysis."	The theory that guided this case study is s learning theory (Wenger, 1998). Importan concepts are communities of practice and the mathematics teacher makes meaning what she is learning and applies that mean to inform her practice.

(Source: Yin, 2003, pp.13-14)

The theory that guided the study is *learning as social participation* (Wenger, 1998), which falls under the broader umbrella of sociocultural theory (e.g., Vygotsky, 1934/1986). Sociocultural theory recognizes that engagement in social practice is the fundamental process by which we learn and become who we are (Wenger, p.4).

Single-case, holistic study. Yin (2003a) explained that a single-case design should be used when the researcher will analyze one set of contextual conditions. This case analyzes a single context—one experienced teacher's practice and how she transforms that practice. According to Yin, a descriptive, holistic case study analyzes the entire phenomenon as a whole, as in this study.

Three of the five rationales that Yin (2003b) identified for using a single-case design further support the decision to study this case. A rare phenomenon and/or context calls for an *extreme* or *unique* case. A *longitudinal* case is used when the researcher can study the same single case over time (pp.47–49). What makes this *longitudinal* case *unique* is the case subject, an experienced teacher of 20 years who changes her practice, which results in exceptional student achievement in a school located in a high needs rural setting. The case study, therefore, meets three of the five criteria Yin described.

Data Sources

Yin (2003b) identified six sources of evidence for case studies: documents; archival records; interviews, which he further distinguished as either in-depth interviews or focused interviews; direct observation; participant-observation; and physical artifacts (p.86). Multiple sources of evidence comprise this case study**.** The data set used for the analysis is comprehensive but is primarily composed of data collected by the ATTP project evaluator and ATTP project leadership team (of which the researcher is a

member) over the course of the project (spring 2008 through December 2013). One of the strengths of using a case study method for research is the ability to use many different sources of evidence. Thus, as shown in Table 4, I use data from interviews, observations, and other documents to conduct ongoing analyses, thereby ensuring that I use appropriate evidence to define the teams and develop findings.

Table 4.

Data Sources

Item	Description	Timeline	CoP Evidence Initia Analysis
Application	7 item application that includes applicant infor employment history, education, professional growth, curriculum vita transcripts, and 3 open- questions.	Year 1: Fall 2008 (pric start of project)	
District Letter of Support	One page district letter detailing why the applic should be selected as a participant in the projec	Year 1: Fall 2008 (pric start of project)	
Interview	5-question interview pr to establish a baseline o applicant's understandi how students learn.	Year 1: January 2009 (to start of project)	
Trait Self-Assessment	40-item trait self-assess (baseline) and an additi 40-item trait self-assess and 7 open-ended quest that are reflective of the subject's confidence an of self-efficacy.	June 2009 (baseline) June 2010 June 2011	
Open-Ended Questions	7 open-ended reflective questions to uncover the elements of the project t subject felt influenced h practice.	December 2013	
Network Survey and sociogr	Survey to examine the professional network th developed between the and other project partici Sociograms were create survey data as part of th analysis.	Spring 2012 December 2013	X
Feedback Questionnaire	Reflective survey with l open-ended and rating s	Spring 2012	

Table 4 (continued)	questions that addressed subjects own knowledg practice, reflective perc of their experience in th project, qualitative resp about the value of proje components including t network.		
My Classroom Then and No Reflection	Subject's personal refle on her classroom then a now, why she changed a what she noticed as a re implementing sound assessment practices in classroom.	Spring 2012	X
PowerPoint Presentation	Description of journey i project and key element affected practice with examples of student wo	August 2012	X
Implementation/Impact Doc	14 fields with questions summarize sharing of p strategies, tools, reading other information relate mathematics improvem	Fall 2009 – September	
Classroom Observations	Completed Reform Tea Observation Protocol (F Jointly completed by 2 observers. Overview of lesson by observer 1 an general overall observat comments by observer 2	April 2009 (baseline) September 2009 May 2010 March 2011	X
Advanced Placement Annua Results	Description of AP; AP instructional planning r including multiple choi free response summarie	2010 (baseline) 2011 2012 2013	X
Interviews	8 of the subject's studer were interviewed about learning experience in t teacher's classroom. Th teacher was also intervi about the role that asses had in strengthening tea and learning.	Spring 2013 Transcribed June-July	X
	An additional teacher interview was complete early August and transc	August 2014 Transcribed August-September 2014	X
Unit of Study	Subject designed unit o focused on a math conc the AP curriculum that students have traditiona struggled with.	Spring 2012	
Teacher and Student Work Samples	Teacher instructional ex that illustrate how her understanding of the	Fall 2009- December 2	

Table 4 (continued)	application of tools and strategies evolved over Student work examples illustrate learning of the curriculum.	
Email correspondence	Additional data on subj background.	February and March 2(

Yin (2003b) described *converging lines of inquiry* as a "process of triangulation and corroboration" that is made possible by collecting data from multiple sources (pp.97-101). In using converging lines of inquiry to corroborate the findings from a case study, the researcher must use multiple sources of evidence to address the same findings to ensure construct validity and reliability (Yin, 2003b). The primary sources of data used in the analysis of teacher learning were interviews, questionnaires, and classroom observations. These data are triangulated in the description of one veteran mathematics teacher's learning experience while participating in the Appalachian Teacher Partner Project.

Data Collection

Yin (2003b) identified three principles of data collection for a case study that are necessary and which speak to construct validity and reliability: (1) using multiple sources of evidence, (2) creating a case study database, and (3) maintaining a chain of evidence. Below I describe how the study adhered to these three principles so that evidence chains are developed in the data analysis phase and so that readers of the case can follow the chain of evidence from the question to the conclusion. Transparency of process also increases the reliability of the study. Data for this study are existing data from the NSF-funded Appalachian Teacher Partner Project. There will, however, be an additional round of interviews and member checking inherent in this study (see analysis section below).

Multiple sources of evidence were used in the analysis and described in the Sources of Data section above.

Case study database. Building and maintaining a case study database increases the study's reliability because it allows other researchers to review all the evidence used rather than just what the initial researcher chose to report (Yin, 2003b). The database for this study includes case study notes, which Yin argued is the most important component. The secondary data is organized by date collected and type of data. All project data, described in Table 5 above, were catalogued chronologically to allow for easier access to necessary documents and researcher narratives.

In addition to keeping an organized case study database, I also follow a detailed case study protocol in order to maintain a chain of evidence. The case study protocol includes an overview of the case study project, including objectives, issues, and relevant literature; field procedures, including human subject protection procedures, sources of data, and procedures for data collection; and case study questions, including both the questions and potential sources in the case study data to answer the questions. The questions guide the narrative in the case study database and serve as a guide for the case study report (Yin, 2003b). Yin also says that all case study data must be available in order for a third party to evaluate the accuracy of the case study report. In addition, the database should enable another investigator to follow the chain of evidence along each step in the case study, including case study questions, protocol, citations to specific evidence in the database, and report. My case study database includes all project data as notes and narrative drafts of my ongoing reflections on the case study questions.

Case Study Quality

Yin (2003b) notes common tests for the quality of social research specifically to case study method (p.34). Of the identified tests, construct and reliability are essential to this study. Yin defined construct validity as "identifying correct operational measures for the concepts being studied and reliability as "demonstrating that the operations of a study—such as the data collection procedures—can be repeated, with the same results" (p.34). In Table 5, I describe how the study will meet the criteria for case study quality. It should be noted that both the construct validity and reliability tactics are applied during the data collection phase of the study (p.34).

Table 5.

Case Study Quality Tests and Application

Tests	Case Study Tac	Case Study Tactic
Construct valid	Use multiple source secondary evidence	Multiple sources of secondary evidence wi include, for example: interview data of teac and students, classroom observations and observer notes, questionnaires, surveys, stu work samples, teacher unit plan, sociogram other artifacts such as teacher-created documents.
	Establish chain of evidence	A case study database will store all of the c collected, which will allow others and me t follow the chain of evidence from case stuc questions to conclusions and vice versa.
	Have key informan review draft case st report	The case subject member checks the conclu to check interpretations of events. While s may disagree with my interpretations and conclusions, we "should not disagree over actual facts of the case" (Yin, 2003b, p.165
Reliability	Develop case study database	A case study database to store all project da including of my notes and reflections.

(Source: Yin, 2003b, p.41)

Secondary Data Analysis

Secondary analysis of qualitative data is the use of existing data to find answers to research questions that differ from the questions asked in the original research (Hinds et al., 1997). The bulk of data used in this study is from an existing dataset from the NSF-funded project previously analyzed and collected by an external evaluator. That evaluator conducted a primary analysis based on the original ATPP goals and objectives. Thus, this holistic case study analysis is appropriately termed a secondary analysis of the data. Secondary analyses of qualitative data has gained interest among researchers who recognize that the datasets offer narratives that have never been analyzed but that discuss issues that relate to the primary research questions. In this case, I conduct a secondary analysis to address new research questions related to dimensions and characteristics of negotiating transformative participation, not related to the original NSF funded goals using the previously collected data from the NSF project. For this study, some additional data were collected by the researcher, including a second interview and email exchanges that were used to clarify, expand, or fill in gaps that existed in the data after the initial analysis of the previously existing NSF dataset.

Inductive Categorical Analysis

Qualitative data analysis is inductive in that the researcher makes meaning from the data, beginning with the specific data and ending with categories and patterns (McMillan & Schumacher, 2010). Using Mayring's (2000) approach to data analysis, I begin with a categorical induction based on previously developed conceptually grounded categories articulated by Wenger (1998) that distinguish a CoP from other learning communities. The initial categories of mutual engagement, joint enterprise, and shared

repertoire were coded for in the transcribed interviews. I then analyzed the interview data to identify examples that illustrated the stages of development of a CoP. After establishing that the ATPP operated as a CoP, the coding shifted to focus on the ways that Jennings negotiated participation and changed her practice as described in *Communities of Practice* (Wenger, 1998). As Mayring suggested, after 10 to 50 percent of the data had been analyzed, I conducted a formative check for reliability by interviewing Jennings. The interview outline used to gather the additional data is included as Appendix B. The interview helped to ensure that the emerging themes were accurate. The themes were constantly compared to the research questions. The analysis continued until all data had been analyzed, at which time I worked with Jennings on member checking and a summative review to verify reliability. At this stage of the analysis, I used the data to formulate findings of the case study (Glesne, 2011).

Validity. McMillan and Schumacher (2010) defined validity in qualitative research as "the degree of congruence between the explanations of the phenomena and the realities of the world" (p. 330). They outlined ten strategies to enhance validity. Table 6 outlines how the case study will consider most of these strategies.

Table 6.

Validity for Case Study Data Collection and Analysis

Strategy	Description	Case Study Application
Multimethod strat	"Allows triangulation in data collection and data analysis	By collecting multiple sources of (interviews, observations, docume I can corroborate findings with multiple sources.
Participant langua verbatim account	"Obtain literal statements of participants and quotations from documents	Original interviews transcribed verbatim; in addition, participant language for terms including cultu language (e.g., ideals instead of ic will be kept in tack as much as po throughout the study.
Mechanically rec data	"Use of tape recorders, photogra and videotapes	Transcription of video footage of previously conducted student (8) interviews and an interview with Jennings.
Member checking	"Check informally with particip for accuracy during data collecti	The subject reviews transcripts ar draft of the case study report.
Participant review	"Ask participant to review researcher's synthesis of interviews…for accuracy of representation	Similar to member checking, the subject, Danielle Jennings, reads t mid-project interview transcript fo accuracy as well as a draft of the study report.
Negative or discre data	"Actively search for, record, ana and report negative or discrepan that are an exception to patterns that modify patterns found in da	As Yin (2009) urges, I searched fo evidence of rival explanations for inferences throughout the case stu

(Source: McMillan & Schumacher, 2010, p.330)

Glesne (2011) presented more general checks of trustworthiness for data analysis, asking the following questions: "What do you notice? Why do you notice what you notice? How can you interpret what you notice? How can you know your interpretation is the right one?" (p.210). Posing these questions will overlap with some of McMillan and Schumacher's validity checks—such as negative cases and spending enough time at the

research site—as well as offer some new ones, such as considering my own biases and predispositions and enlisting other researchers' feedback on my interpretations (2010).

Limitations

The findings from the case study will not be generalizable, but that is not the intended purpose. The purpose is to provide a deep and holistic understanding of the phenomena and the particulars of the case. In case study research, the researcher is the primary instrument of data collection and analysis; this can be a limitation depending on the integrity and compassion of the researcher. In this study, the researcher has had intensive involvement providing support for mathematics and science improvement in the Appalachian Region through numerous grant projects. The context for this case is Appalachia. I grew up in Appalachia and later took courses focused on understanding the challenges of schooling in rural places. This involvement and the nineteen years I have spent working with rural schools on their mathematics and science improvement efforts have contributed to my extensive knowledge of the contextual factors that can impede or support reform.

In addition, the researcher was the Project Director for the Appalachian Teacher Partner Project. In this role, I helped to design the professional learning experiences for the project. Knowing that my role in the project can influence my perceptions of what occurred, I employ a system of rigorous self-questioning focused on the research questions as a way to control for bias.

Summary

This single-descriptive, holistic case study focuses on a high school AP mathematics teacher involved in a dual-faceted, multiyear professional development project and how she negotiates meaningful participation and through those experiences applies those meanings to transform her classroom practice. Wenger's (1998) theoretical framework of social learning theory as it relates to learning as a social experience informs the study.

Chapter Four

Findings

Danielle Jennings: A Story of a Third Generation Teacher and Her Perceptions of Classroom Practice

Instilling the Value of Education. Danielle Jennings' parents grew up in rural Brooke County, Kentucky, and graduated from the county's only high school. Her father was one of four children. After high school, he entered the military, but his siblings all attended and graduated from Berea College in Kentucky. "Berea College was founded by ardent abolitionists and radical reformers whose purpose now and historically has been to promote the cause of Christ. The College has a history of providing educational opportunities primarily for students in Appalachia who have promise but lack resources" (Berea Mission Statement, 2015). "Berea was a godsend to my father's family," Danielle said (D. Jennings, 2015).

Danielle's mother went to college to pursue an education degree at Eastern Kentucky University, following in *her* mother's footsteps. After completing her degree, Danielle's mother returned to her alma mater, Brooke County High School, to teach science. However, after one year, she and her high school sweetheart were married. She joined him for the remainder of his tour in the military, during which time Danielle was born. After years of transferring their children to different schools in Florida, San Diego, Virginia Beach, Maryland, and Massachusetts, Danielle's parents returned with their four children to Brooke County in 1978, after Danielle's father retired. Danielle was midway through sixth grade at the time and was enrolled in the county's only middle school. She would later graduate from Brooke County High School, the school that generations of her

family had attended. Danielle recalls that several of her teachers were “fantastic, and many really cared about me. My high school algebra teacher, Abner Tool, was legendary. I also remember Becky Black, who was traditional, but we worked every problem in the math book. She was also my cheer coach, and I worked for her father selling shoes to help earn money to go to school (D. Jennings, 2015).”

After graduating from Brooke County High School, Danielle, and three of her siblings, attended and graduated college.

> It seemed expected. There were no jobs in our area. So unless we entered the military, like my dad, my parents expected and supported us going to school. My sister had a teaching scholarship to Eastern Kentucky University, one of my brothers had a full engineering scholarship to the University of Kentucky, and my other brother attended Morehead and studied mechanical engineering (D. Jennings, 2015).

Danielle discovered that she could receive a math/science incentive loan to pay for most of her tuition, if she agreed to teach in a rural setting. Although she had saved money for college from her work in the local shoe store, she took advantage of the loan and in 1988 graduated from Eastern Kentucky University (EKU) with a secondary education mathematics degree (D. Jennings, 2015).

Third Generation Teacher. Danielle Jennings is a third generation teacher, as is her sister, preceded in the profession by their mother and their grandmother. All four attended and graduated from EKU, which was known as a teacher college when her mother and grandmother attended. All three generations secured positions teaching in Brooke County. Danielle’s grandmother taught 5^{th}–8^{th} graders at a local elementary

school for over 40 years. “She was a math whiz. She and my grandpa loved working those math magazine puzzles, cryptographs, and logic problems. Every time I visited as a child, she had a paperback of crosswords and math games going” (D. Jennings, 2015). Danielle’s mother taught at the high school and retired after 30 years. Danielle said that she did not have her grandmother or mother as classroom teachers, but she was in her mother’s homeroom each year of high school.

Although Danielle currently teaches at Brooke County High School, it was not as easy as she thought it would be to secure a math position in her home district. “When I graduated in 1988 summa cum laude with a B.S. in secondary mathematics teaching, a minor in applied statistics, and as the Outstanding Senior in Mathematics, I thought I would easily find a job in Brooke County.” However, due to politics, she was not welcomed with open arms.

> That particular superintendent told my mom that as long as *she* had a job, we should be ‘thankful.’ As long as [her mother] worked there, I would not be considered for a job. The school system has been the only source of employment in our county for years, and you are fortunate to have one family member working in the school system (D. Jennings, 2015).

Consequently, Danielle applied to teach in a neighboring county where she had done her student teaching. However, the district was not willing to hire her despite her supervising teacher’s endorsement. “It was shared with me that I wasn’t considered because I was from another county. I was crushed” (D. Jennings, 2015).

Danielle went to graduate school full-time to increase her chances of securing a job. But before her master’s was complete, she was offered a teaching position in a

district adjacent to Brooke County, which she accepted. “It was too good to pass up,” she said. Danielle believes that two reasons led to her successfully securing the position: (1) there were no in-county applicants and (2) her best friend from high school and college, who was leaving her position at the school, recommended her.

Danielle has vivid memories from her first years of teaching.

> I had no idea what I was doing, so an experienced teacher allowed me to watch her teach every day. My planning period was first period, and I spent my entire first year watching her teach her pre-cal class during my planning time. She was not my Kentucky Teacher Internship Program (KTIP) teacher. Interestingly, my assigned KTIP teacher worked as an elementary special education teacher at another school. She would make me come to her school at the end of the day and I would watch her grade papers (D. Jennings, 2015).

After school, Danielle would commute to EKU, where she and her husband lived in married-student campus housing while he attended the university. From 1989 to 1992, Danielle capitalized on her easy access to the campus by completing her Master of Science degree, attending classes as her schedule allowed, then going on to also complete her advanced teaching Rank 1 KY certification. Accumulating 60 hours of graduate classes in mathematics content and mathematics education, she secured both an MAED in mathematics education and an M.S. in mathematics. “Earning a master’s enriched my career so much, because it allowed me to teach college courses and calculus in the high school setting” (D. Jennings, 2015). Danielle planned to pursue a doctorate at the University of Kentucky, but a crisis occurred with her husband’s father that brought them both back to Brooke County, where they have remained.

Danielle Returns to Her Hometown Alma Mater. After starting her teaching career in two neighboring districts in Appalachia, Danielle secured a full-time high school mathematics teaching position at Brooke County High School in 1990. She said the Kentucky Education Reform Act that had passed that same year played a key role in her ability to secure a position in the county, despite what she was told when she first applied to teach there.

> The year I began teaching at Brooke County High School was the beginning of education reform. Districts had to start looking for capable and competent people instead of just considering politics. As soon as we hired a new superintendent, my sister and I were both hired as mathematics teachers. This was all due to school reform. She and I benefited because of the changes to the system (D. Jennings, 2015).

Jennings also teaches part-time as an adjunct professor at an EKU satellite campus close to her home, a role she began in 1992 and continues today.

Danielle's Initial Years at Brooke County High School. During her first year at Brooke County High School, Jennings said that she "volunteered to teach anything. I wanted it that way so I might be able to have different kinds of students" (D. Jennings, 2015). This has allowed her to teach a range of classes over the course of her career, including Basic Math, Algebra I, Advanced Algebra II, and Advanced Topics. Initially she taught Basic Math and Algebra I, but she eventually was the school's sole Algebra I teacher until school reform efforts placed increasing importance on student math portfolios. School administrators wanted Jennings to teach only the students that would be tested as part of the new requirements under the Kentucky Education Reform Act

(KERA); thus, she was put in charge of all senior math portfolios. During that time, Jennings mainly taught Advanced Topics and pre-calculus. Then two senior teachers retired around 2000, at which time Mrs. Jennings inherited calculus. She was the first to teach Advanced Placement (AP) calculus once it was offered at the school in 2003. "We had a couple of students who were fairly advanced, and they wanted to take AP. So we did establish an AP class. At that time, I was happy just to introduce students to calculus, and hoped that a few—one or two students—would pass the exam" (Zeidler-Watters, personal communication, 2014). Jennings said that she received "zero support" in terms of materials or training to teach the course.

In 2000, Jennings assumed the role of department chair, as she was the veteran math teacher, and she continues to serve in a leadership role in the department today. Interestingly enough, but not necessarily an uncommon occurrence in rural areas, she works alongside her former mathematics students, who now, with the exception of one teacher, comprise the Brooke County mathematics department.

Danielle Jennings' Journey of Change Begins

In 2005, with 17 years of teaching experience, Jennings' school district approached her about pursuing a leadership role within the district as a mathematics coach. To help with that role, she participated in the Kentucky Center for Mathematics coaching cadre. Other than her formal education and the coaching training, Mrs. Jennings' past efforts to improve her practice often had been limited to what she calls the "professional development carousel," which she described as "local people leading training during the first few days of school and that was enough for us. My district did

not support out of district training until recently so my choices were limited" (Zeidler-Watters, personal correspondence, 2014). Of the four required professional development days, Jennings explained that two were normally typically offered at the beginning of each year for general professional development led by her local district leaders. The other days were typically taken up by required training for all school teachers at each school, on topics such as Safe Schools.

In 2006, this generic approach to professional development changed. Free training sessions in mathematics and science were offered to teachers in the region as part of the Appalachian Math and Science Partnership (AMSP). The AMSP was a five-year project, federally supported through funding from the National Science Foundation (NSF). The project provided professional learning experiences at various locations throughout the Appalachian region in order to limit the travel for the educators and leaders in the partnership districts.

Jennings took advantage of the offerings from the AMSP, and after attending two trainings sessions, she applied for and was accepted to serve as a project leadership intern in 2007 for one year. This position provided her school district with financial support for her part-time release from the classroom and afforded her an opportunity to work with other mathematics teachers. As part of her internship work, she engaged in training related to coaching, providing local professional development, and leading the middle school math professional learning community (ATPP application, fall 2008).

Danielle Jennings Selected as Participant in the Appalachian Teacher Partner Program

In 2008, the AMSP project submitted a supplemental project request to the National Science Foundation to develop 18 teacher leaders from participating Appalachian districts across three states. The proposal was funded, and the Appalachian Teacher Partner Project (ATPP) project began in the fall of 2008. In the spring of 2009, 18 secondary teachers were selected to participate, 15 of whom taught mathematics (9 from Kentucky, 3 from Tennessee, 3 from Virginia). The other three participants taught secondary science in Kentucky.

Jennings was one of the nine secondary mathematics teachers from Kentucky accepted into the ATPP. Although she had significant training in mathematics and mathematics education through her course work and 20 years of experience teaching high school mathematics, she said that when she applied to be part of the new project she was restless. “I felt like I was not making a difference, and I saw my students settling for mediocrity (D. Jennings, 2005).” She knew something was not right with the mindset of her students but did not know how to begin to address the challenge to move them forward. At that time, she also “thought the ATPP would provide a wonderful extension to my initial goal: to improve mathematics instruction and achievement in my district” (ATPP application, fall 2008).

Reflecting on what her teaching style was like at the time she began the ATPP, Jennings said,

> I used to hand out a syllabus on the first day of class and proceed to stand and deliver each lesson. I was very organized, with each section quiz and unit test

> neatly placed in sheet covers in a binder I had used for several years. I assigned homework each night and routinely checked it off the next morning on a checklist mounted to my trusted clipboard to make sure the students had completed the assignment. The students faithfully wrote all of the homework questions on the board so we could all check the answers together. The grades on each assignment were recorded, tests were completed, and I moved on to the next section as indicated on the syllabus. My students were compliant, and I thought with the structure I offered, I was setting high expectations. The expectations though were more of how to succeed in the classroom rather than to master the learning targets. My students could easily tell you what they did each day, but not necessarily what they had learned (D. Jennings, self-reflection, spring 2012).

The project appeared to fill a void in Jennings' professional career. "I wanted more for my students and myself. I wanted to get outside of my classroom and have fellowship with other teachers. We simply had no collegiality at my school," she said (D. Jennings, 3/2/2015). She saw the ATPP as a natural extension to further support the work she had been doing in her role as district mathematics coach and part-time classroom teacher. Jennings was in search of ways to continue to meet the needs of her students and was open to learning.

As part of her ATPP application (fall 2008), Jennings was asked to share her reasons for wanting to participate in the project and to explain what she hoped to accomplish. She responded,

> I no longer want to waste energy on events beyond my control but rather to focus on improving things within my control as a teacher. I want to improve math

instruction by feeling empowered, empowering others, and working together to achieve understood and common goals.

Jennings was clearly motivated to try things in her practice and share them with other teachers, as long as she was able to see the connection to improving student learning.

Research Question 1. ***How did an experienced secondary mathematics teacher, involved in an ongoing and intensive professional development program, negotiate meaningful participation in a community of practice?***

Developing "Peer" Relationships (Collegial Trajectory)

Jennings negotiated her participation in a community of practice through the collegial relationships she developed with the other project participants and the facilitators through her ongoing interaction at ATPP full-day monthly meetings, annual summer sessions, and other project experiences. These relationships were built on trust, rapport, and common interest. Jennings formed an even stronger bond with a sub-group of teachers within the whole cohort of teachers in the ATPP. For my initial analysis I termed this sub-group her *Peer CoP*. In this section I use Wenger's Stages of Development for a CoP—potential, coalescing, active, dispersed, memorable—as organizing concepts to characterize Jennings' evolving participation with this *Peer CoP*.

Potential Stage: Danielle Begins to Explore Commonalities and Begins to Form

Relationships

Wenger, et al., (2002) describe the initial stage of CoP development as the "potential" phase, which is a time when "people face similar situations without the benefit of a shared practice" (p.13). Arguably, the Appalachian Teacher Partners (ATPs)

shared the practice of teaching mathematics generally, but not necessarily the "mathematics knowledge for teaching" (Ball, 2003) or pedagogical content knowledge. Jennings herself was seeking ways to improve "practice" and was in the program to develop her competencies "to improve mathematics instruction and achievement in Brooke County" (ATPP application, March 2008).

During the potential stage, Wenger et al., (2002) indicate that typical activities often include "discover[ing] commonalities" (p.13). From the initial ATPP project meeting in March 2009, Jennings began to identify things members of the group had in common.

> I think looking back from the very first meeting, we met in London, Kentucky, so proximity and location were bringing us together. We came from similar schools with similar challenges and looking at everybody it just seemed like a lot of us were in the same place in our career...The project listserv itself kind of grouped us together, that we were going to have opportunities to communicate about the work (Zeidler-Watters, personal communication, 2014).

The 2009 ATP meetings were held at about the same time that the state of Kentucky was beginning to implement new legislation that would affect all schools systems in the state: Kentucky's Senate Bill 1. Although this was an *external mandate*, "Senate Bill 1 was a common thread that pulled the KY group together. We had a common goal from the beginning," Jennings said (follow-up interview, 2014).

The ATPs from Kentucky who taught mathematics knew that programmatic changes were on the horizon for their discipline with the passing of the Bill for one key reason: it required that standards in mathematics be revised or new ones adopted, which

would mean changes in assessment. For years, teachers from Kentucky and across the nation had been hearing about an agenda to develop national Common Core State Standards in mathematics and language arts. Kentucky was on a path to become the first state to adopt and assess these new national standards. They also understood that one of the district's expectations for the Appalachian Teacher Partner Project was that the ATP participant would be included on the local district leadership team that would develop, support, and help execute the plan to implement the requirements of Senate Bill 1. "This expectation changed the conversation among the Kentucky Appalachian Teacher Partners," Jennings said (interview, 2014). This requirement of Senate Bill 1 appeared to be a turning point, because ATPs in Kentucky, who were going to be involved in district level activities—as part of the leadership teams in the district—would have a voice in these district level conversations.

> So one of the smaller initial networks became, "We are going to have to go back and provide math leadership in our district. A lot of the conversation began around, what are you going to do? How is your district doing that? What are they asking you to do? What do you think they might have you do?" That was the initial contact and then it became more—instead of just emailing through the listserv, some of us were developing more of a personal relationship and we would email each other directly (Zeidler-Watters, personal communication, 2014).

This interaction changed the way Jennings negotiated her participation within the group through developing a leadership role with the ATPs (discussed more fully below).

Coalescing Phase: Danielle's *Peer Community of Practice* Develops.

In the coalescing phase, members come together and recognize their potential, according to Wenger et al. (2002). The ATPP participants recognize potential in their collaboration and they begin to coalesce. The *Peer CoP* can be likened to a Craft Guild of Medieval times. The members were journeyman--a fraternity of highly skilled and respected teachers--not yet at mastery but on the precipice of exhibiting their craft for jurying by masters. The following account allows a glimpse into the further development of Jennings' Peer CoP.

Training for ATPs with Educational Experts on Classroom Assessment

In the summer of 2009, the *Peer CoP*, along with the other ATP participants and project leadership, attended a two-day session on *Leading Professional Development in Classroom Assessment for Student Learning* (CASL). Jennings attended this initial training as a member of her district's leadership team that would be working to help implement the requirements of Kentucky Senate Bill 1. Members of Jennings' *Peer CoP* attended the same two-day session. At this session, "I was able to introduce my supporting leaders from the district to other ATPs, we sat with our district team, but we were in contact with each other during breaks" (Zeidler-Watters, personal communication, 2014). All district representatives from across the state who attended the leadership session received the *CASL* book and supporting materials. These resources served two purposes: (1) to further develop the team's capacity to lead the work locally and (2) to provide guidance on how to form local learning communities of teachers and leaders. Classroom level assessment became a critical component of building capacity for

educators—something that many teachers did not receive as part of their undergraduate program.

Kentucky Senate Bill 1 (SB1) required that all existing standards in mathematics be revised or adopt new standards. Kentucky adopted the Common Core Standards for Mathematics and English Language Arts. Jennings said, "The local district leadership had expectations that we, as ATPs, would help support the professional development aspects that would come into play as part of implementing the requirements of Senate Bill 1" (Zeidler-Watters, personal communication, 2014), thus further uniting the Kentucky mathematics participants who would now have similar local responsibility for implementing of these new standards.

Jennings, along with the others, recognized that their group was no different than the other districts attending. They were all starting from a similar place in learning to implement SB1

> All of the Kentucky ATPs were from districts where we felt we were not in the know…we were districts that weren't typically up at the top as far as student performance, we were down toward the bottom. So we thought, because of the changes that all the districts in Kentucky were going through with the implementation of Senate Bill 1, this will going to give us a *level playing field* (Zeidler-Watters, personal communication, 2014).

From this point forward, "The playing field was leveled," to use Jennings' words. From her perspective, all local teachers and leaders in Kentucky now had an equal chance at improving student learning. Several things contributed to this equality, including the use

of the same assessment training and support materials as well as the networks established in Kentucky that would provide ongoing training and support for Senate Bill 1.

Jennings is Granted Release Time from her District

As her *Peer CoP* was continuing to develop, Jennings' role within the group was also evolving. Her district provided her release time during the school day to work on project activities and coach other mathematics teachers—a professional accommodation that ***none*** of the other project participants had. This time allowed her an opportunity to reflect on and utilize what she had learned at ATPP professional learning sessions.

It was during her release time that Jennings also met with her district team to reflect on what they had learned at the *CASL* session. According to Jennings, her release time may have helped position her centrally in the community of practice, and especially in her *Peer CoP.* She and her group were discovering commonalities and further coalescing by exploring their connectedness and recognizing their potential as a group. She literally had the *time* and was *willing to share* with other CoP members the resources and information she and her district team were compiling on how they planned to roll out Senate Bill 1 requirements locally. Jennings recalls,

> We were being asked to work as a district to support teachers and leaders in furthering their understanding of classroom assessment literacy…I think they [*Peer CoP*] started looking towards me a bit for guidance. It was a bit more natural for me because of my half time release, I worked with my district team and created PowerPoints and things that we were going to share with our district. That was something that I was certainly offering to share with them [*Peer CoP*] (Zeidler-Watters, personal communication, 2014).

For Jennings and her *Peer CoP*, the *CASL* training allowed for mutual engagement around a common phenomenon: classroom level assessment. Further, Jennings' release time allowed her to synthesize information from the *CASL* and other ATP trainings and experiences, and distribute resources to the CoP. She was developing the artifacts that would become part of the group's shared repertoire for implementing changes in their practice and for carrying out professional development in their districts. "That's when we really started communicating beyond when we would just see each other at our monthly meetings. Senate Bill 1 kind of helped push that relationship," she said (Zeidler-Watters, personal communication, 2014).

Active Phase: A Shared Repertoire and Intellectual Partnerships Develop.

Negotiating Participation through Intellectual Partnership

During the Active Phase of CoP development, members engage in developing a practice (Wenger et al., 2002). Within six months of the *CASL* training with their district leadership teams, all of the teachers with whom Jennings was continuing to develop a close relationship—her *Peer CoP*—attended a weeklong Association of Supervision and Curriculum Development (ASCD) Institute led by Dr. Carol Ann Tomlinson[1] and Dr. "Tr." [Teacher] Harvey Silver[2], noted experts in education. The Institute, which was held on Hilton Head Island, South Carolina, focused on differentiation and *Math Tools,*

[1] Carol Tomlinson: http://caroltomlinson.com/; reviewer for eight journals and is author of over 200 articles, book chapters, books, and other professional development materials.

[2] Harvey Silver: http://www.thoughtfulclassroom.com/index.php. Nationally recognized author, presenter, trainer, and coach for 40 years; President of Silver Strong & Associates and Thoughtful Education Press; He was principal consultant the Kentucky Thoughtful Education Teacher Leadership Program.

Silver's book. Tomlinson and Silver developed the ASCD resources used during the Institute.

This experience provided an additional opportunity for Jennings to further negotiate her participation with the group through prolonged intensive mutual engagement in a shared professional experience. It also created an environment conducive to moving Jennings' and her *Peer CoP* to its Action Phase. Indeed, this trip seems to have played a crucial role in cementing the creation of Jennings' *Peer CoP* by allowing the teachers to bond. This bond was forged not only by the members attending the session and reflecting on their experiences, but also by traveling together, which helped to build camaraderie. This trip provided numerous opportunities for the growth of both interpersonal and professional dimensions of the intellectual professionalism that was beginning to characterize Jennings' participation and will be described in more depth later.

Several interpersonal relationships that would later become integral to Danielle's professional one appear to have been created or cemented during the ASCD institute. "Several of us discovered that our children are in the same grade and would be college freshman at the same time, so we started learning the children's names and creating warm personal bonds through travel and spending a lot of time together" (Zeidler-Watters, personal communication, 2014).

Having multiple opportunities to interact both on an interpersonal and professional level allowed the *Peer CoP* to further develop. Wenger's work (1998) supports this notion, in that he suggests that common threads and infrastructure are needed as a basis for growth in a CoP. The formation of Jennings' Peer CoP offers

additional evidence of the importance of personal and professional interaction. Jennings said,

> The buzz coming back after the institute was over was that we are going to work with Harvey Silver over the course of this project so we get to know him one-on-one. He was just so far above and beyond any local professional development experience that any of us had participated in. None of us have been allowed or had the opportunity to attend a national conference or have any real rich math focused professional development. Most of us worked in a district where they had a local professional develop carousel with local people that occurred during the first few days of school and that was enough for us, which was what we were used to. It didn't take a lot of conversation to figure out we were all in the same boat with that (Zeidler-Watters, personal communication, 2014).

Intellectual partnership, which are *more* than just exchanging strategies, but an authentic intellectual give and take where all parties engage and benefit evolved from both external and internal opportunities for professional growth. The external experiences with educational experts and the internal group growth appear to have created a coherent interplay that resulted from Jennings' social learning experiences. Internal and external experiences and mandates appeared to have shaped her participation and led to the creation of relationships with other participants and experts in the field of education. Her legitimate participation provided Jennings the understanding that allowed her to make meaning of project experiences and apply that meaning to her classroom practice. Through implementation in the classroom, she was able to further refine and cement what she was learning and experiencing.

Jennings' participation in ATP activities is represented as an arc in Figure 7. This graphic displays the various ways in which Jennings participated personally and professionally during the five years that she was involved in the project. The "external mandated participation" at the top of the arc shows the regulations required in the state during the time the ATPP project was funded. These external requirements served as the organizational link for Jennings to apply and demonstrate how her participation was supporting what was mandated. The bottom arc, "internal participation," shows the ways that Jennings was personally engaging with her Peer CoP and external educational experts. The bullets distinguish the various activities that occurred in the order they occurred during that year.

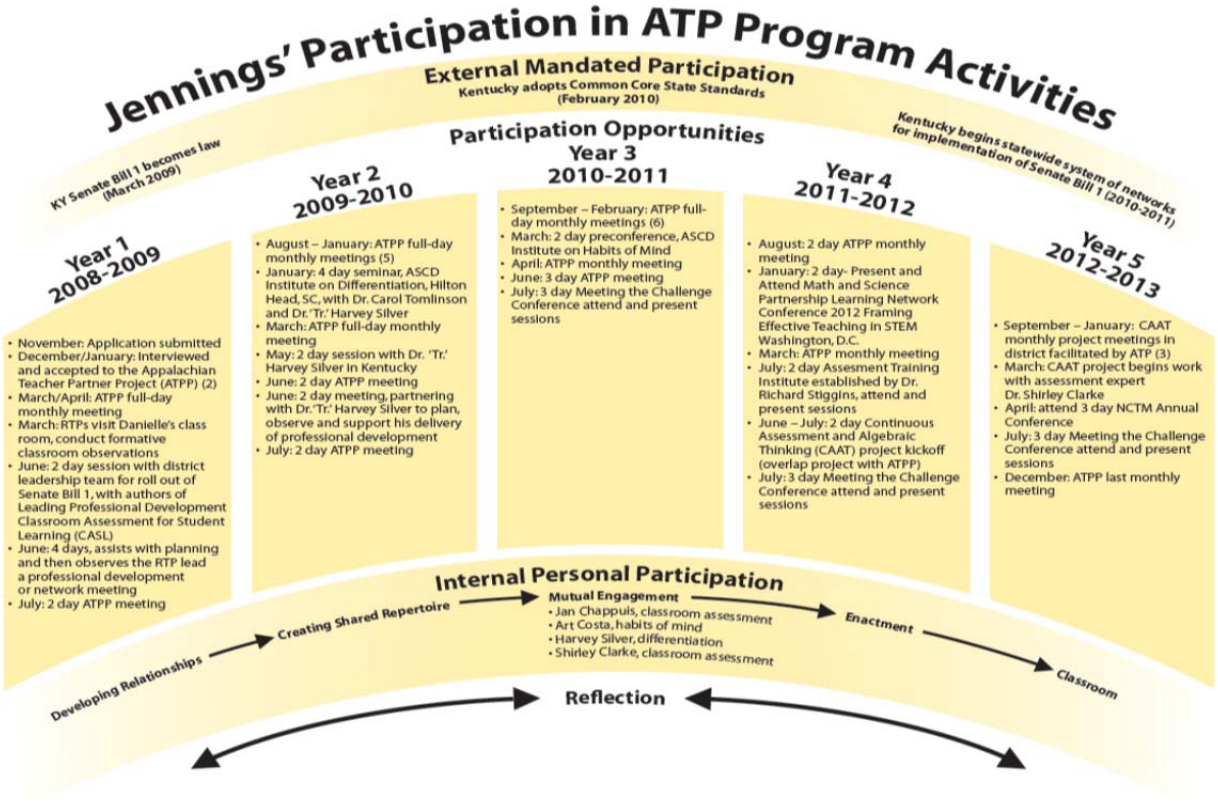


Figure7: Jennings' Participation Over Time

According to Wenger (2010), engagement in social contexts involves a dual process of meaning making: participation (e.g., activities and reflection) and reification (e.g., documents and tools that are reflective of the shared experiences). Wenger asserts that when these two ideas act in concert, meaningful learning can result. He goes on to say that fostering connectivity—in this case by Danielle developing an intellectual partnership through engagement with external educational experts and internally through interaction with her *Peer CoP*—can generate renewed network energy.

Danielle Negotiates her Participation through Development of a Shared Repertoire

A repertoire in a community of practice, according to Wenger (1998), includes "routines, works, tools, ways of doing things, stories, gestures, symbols, actions, or concepts that the community has produced or adopted in the course of its existence, and which have become part of its practice" (p. 83). The repertoire plays a key role in the development of any community of practice. For Jennings, the shared repertoire was critical and it allowed her to further negotiate her participation in her *Peer CoP*. Through conversations about their experiences, the group gained confidence in their ability to implement a shared repertoire, especially tools and strategies for teaching mathematics. Jennings confirmed,

> So coming back—Harvey Silver just really struck a chord with us. So how did this all fit together? Already we were pulling assessment literacy, differentiation, and then Harvey's work with the math tools and just really getting into focusing on individual student learning, so those three made for topics and became the focus of many of our conversations. We really committed ourselves to putting differentiation and *Math Tools* into practice so each of us started to think about a

level of differentiation for our classroom and then developing a task rotation (Zeidler-Watters, personal communication, 2014).

The "fitting together" that Jennings refers to demonstrates that she *and her Peer CoP* were moving from coalescing toward a more active stage of transformative development. At the ASCD Institute the intellectual partnership was moving in the direction of a two way "partnership." Jennings commented, "This is so much more than they've ever been exposed to. I mean just at a totally different level. He really made a connection with each of us personally on that trip because we all knew that we would be participating in a deeper project with Harvey" (Zeidler-Watters, personal communication, 2014). Harvey Silver was developing respect for the teachers, at the same time they were engaging with him on a personal and professional level.

Legitimate Participation

As was mentioned earlier, the ASCD institute on Hilton Head cemented the formation of Jennings' *Peer CoP*, and it was intentional.

> The examples of how Danielle and others were incorporating his work into their classroom practice would later inform Silver's work. The teachers shared their repertoire with Silver and engaged in intellectual feedback sessions with him. In the acknowledgement section to a new publication Assessment Tools, he references these teachers' work and their contributions to his book.
>
> Other educators who deserve special thanks include …Regional and Appalachian Teacher Partners, University of Kentucky's Partnership Institute for Mathematics & Science Education Reform (PIMSER), who inspired this book of assessment tools (HS, 2012).

The Institute group helped each other self-monitor and provided continual reinforcement to one another, thereby helping to legitimize the purpose of the ATPP and spur Jennings to action. “We immediately started talking about a new responsibility on our part to use those strategies in our classroom and then come back and share with each other [during regularly scheduled ATPP meetings]” (Zeidler-Watters, personal communication, 2014), thereby creating a shared repertoire. The Appalachian Teacher Partner Project (ATPP) monthly full-day meetings, summer experiences, and classroom observations helped to further the learning around these key ideas as participants began to share artifacts, such as teaching tools and strategies, with one another. The development of this shared repertoire was an essential element in Danielle’s evolving *intellectual partnership.*

Another dimension helped legitimize Danielle’s position within the intellectual partnership experience. One might ask, were the *teachers* the only ones experiencing a perceived “partnership” for example, with national experts? In other words, was it an actual two-way partnership? Did the expert benefit from partnership as much as the participants? Danielle was interacting with Silver during years two and three of the project. During this time, their intellectual partnership was established. The connection with Silver was immediate for Jennings.

It is hard to put into words the excitement I felt traveling together to the Hilton Head

> Conference. Most of us were attending a national conference for the first time. I was in awe of Carol Ann Tomlinson and Harvey Silver. With Harvey's content being specific to math, I was anxious about the meeting. I had very little math specific professional development in my background. Within the first few minutes

> of the meeting, I could tell I was fortunate to be in the audience. Harvey immediately made individual connections with each person with his practical strategies. I felt like we had known him for years by the time the conference wrapped up. He was so welcoming and encouraged questions and conversation (D. Jennings, 3/2/15).

The intellectual partnership continued to evolve during year two of the program. Silver worked with Jennings through several additional project experiences, including a two-day KY ATP session on *Math Tools* a few months after the initial meeting. The three-day experience included a full-day preconference session, in which Silver worked again with the ATPs at the Kentucky Meeting the Challenge Conference in years three and four of the project. However, the most *unique experience* occurred when Jennings and some of the other ATPs partnered with Silver to prepare and deliver workshops on *Math Tools* and other strategies at several two-day Kentucky institutes in the Appalachian Region. Jennings shared that,

> Working with [Silver] for the PD was so very challenging. He had such high standards and expectations. You could sense how important it was for him for the participants to be engaged and that the training components fostered growth. When he allowed us to tell him our stories and he wanted to know what made us tick, he showed each of us how invested he was in helping us all grow professionally, but he wanted us to understand how challenging it was to work with an audience. He wanted us to have presence. We all had a story, but some were much better than others in the open room (D. Jennings, April 2015).

The examples of how Danielle and others were incorporating his work into their classroom practice would later inform Silver's work. The teachers shared their repertoire with Silver and engaged in intellectual feedback sessions with him. The interaction with the ATPs inspired a new publication by Silver, *Assessment Tools*, where he references these teachers' work and their contributions to his work.

Additionally, Silver trained Jennings and the other ATPs in a new unit development framework that he called the *Classroom Curriculum Design: How Strategic Units Improve Instruction and Engage Students in Meaningful Learning*. They piloted the design for him as they developed their own unit to address a concept that was challenging for the teacher to teach or the students to learn. Once again, an intellectual partnership was established as Jennings and other ATPs were instrumental in informing Silver's design process, and he provided feedback to them throughout the revision process via Skype. Danielle remarked, "What a process that was! We did not take that lightly, we were able to conference with him at that level (Zeidler-Watters, personal communication)." Ultimately Danielle's work unit was packaged as an example of this new model and used by Silver with other groups. Clearly this was a symbiotic relationship, as Silver was also benefitting from the intellectual partnership with Jennings and the *Peer CoP*.

The community of practice was nurtured and coordinated externally by program personnel, but Danielle explained that the group also developed into something that the participants owned.

> The community itself was probably the key to the success of the entire project. Each session was carefully planned and thought through. The leaders worked together to create that type of alignment. The national experts and partners were

> brought in with our specific needs in mind. We were partnered with each other in ways to create common bonds that would last well beyond the limits of the project. The best way to say this is, nothing was left to chance. The leaders and others we worked with nurtured our growth in every way possible. They assessed our needs and taught us all how to be self-directed, self-modifying, and self-reflective (Zeidler-Watters, personal communication).

Intellectual Partnership: Examining Participants' Networks

Jennings was able to situate herself within the *Peer CoP* as a consequence of her interactions within and among the group. As part of the NSF-funded evaluation for ATPP, the project evaluator collected data from participants to develop sociograms in order to visualize participant interactions. These data were collected with a questionnaire administered at the beginning of the project and again at the last project meeting. The same questions were asked at both sessions. The questionnaire asked respondents to designate other participants who they would identify in response to a prompt. For example, a sample sociogram questionnaire item was, "Effective instruction depends on having lessons that are engaging to students and on using strategies that build understanding. Which persons have you found to be the most valuable sources of effective teaching ideas?" The Sociogram Questionnaires are provided in Appendix C. The data used to create the sociograms were reexamined for this study with the primary goal of locating Jennings within each sociogram.

Sociogram Acronyms and Designations

Some of the Appalachian Teacher Partners (ATPs) have two separate designations on the sociograms because, during the last year of the ATPP, another project, the

Continuous Assessment and Algebraic Thinking (CAAT) project, was funded by the Council on Post-Secondary Education. This overlapping project involved six of the ATPP participants and other teachers from their schools and districts. The CAAT was organized and led by the same leadership team as the ATPP. It was seen as another way to deepen the ATPs' knowledge of assessment tools and strategies needed for high quality teaching and learning experiences in the algebra classroom. The CAAT labels on the diagrams refer to this program group. A third group of teachers was also involved with the ATP and CAAT teachers: the Regional Teacher Partners (RTPs). RTPs were a group of teachers funded in a grant prior to ATPP but with similar goals to develop expert teacher leaders for the Appalachian region. These teachers were involved in the ongoing efforts in Appalachian counties to fund math/science teacher development projects. RTPs served various roles in the ATTP program, such as mentoring, coaching, planning meetings, accompanying teachers on ATP trips, and facilitating reflection and discussion among ATP participants.

The analysis of the network data and resulting sociograms allowed me to examine the interactions and relationships between Danielle Jennings, her *Peer CoP*, and other program participants at various points in the project. At the beginning of the project, Jennings said that she did not know any of the other math teachers in the group, as shown in the sociogram in Figure 8.

Sociogram A: Danielle at the Beginning of the Project

The prompt for Sociogram A was, "The list below contains the names of the persons who have been involved in the ATPP. For each person on the list, mark the choice that best describes your relationship with that person before you began working with the Master Teacher Project" (Evaluation Network Survey see Appendix C).

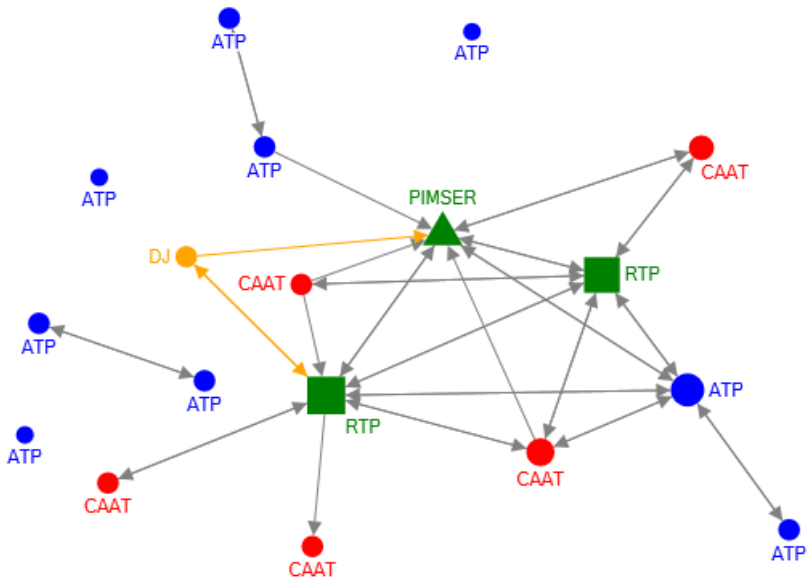


Figure 8. Relationships that existed at the start of the project.

The largest nodes represent the people who were chosen most often by others in the group. In Figure 8 , the largest nodes are represented by the green triangle, which is the PIMSER project leader, and the green boxes, which represent the Regional Teacher Partners (RTPs). The orange node in the diagram represents Danielle Jennings (DJ). The arrows illustrate the connections to and from Jennings. The direction of the arrows goes from the person answering the prompt to the person they indicated in response to the survey question. The size of the nodes is related to the number of incoming arrows or the

number of times that person was chosen by someone else. The other mathematics ATPs, who were also part of the CAAT, are represented by the red circles. These data confirm a connection between project leadership and Danielle Jennings. Jennings knew of, or had been in trainings led by, two members of the project leadership team when she began participating in the ATPP: the PIMSER lead (the researcher) and one of the Regional Teacher Partners. The PIMSER lead (the researcher) did not know Jennings until the project began.

Sociogram B: Distributed but Coalescing Interactions

The prompt for Sociogram B was, "Effective instruction depends on having lessons that are engaging to students and on using strategies that build understanding. Which persons have you found to be the most valuable sources of effective teaching ideas?"

Sociogram B demonstrates the coming together of Danielle and her *Peer* CoP as interactive professionals in an intellectual partnership. It is clear that the six mathematics teachers (select math ATPs and ATP/CAAT)—"my peer group," as Jennings referred to her *Peer CoP*—thought she had experiences and expertise they could learn from and apply to their local situation. The data confirm Jennings' location as an emerging leader in the community, one in which the members worked together to develop a shared repertoire of classroom formative evaluation practices, tools, and strategies to promote an effective learning culture and to help their students engage and learn content.

Of the 15 mathematics Appalachian Teacher Partners (ATPs) displayed in Sociogram B (Figure X,) seven (7) chose Jennings, as did two of the project leaders, which resulted in her being represented by the largest node and the most connections of

anyone in the community of practice. In four instances, Jennings chose the same person who chose her, indicated by an arrow in both directions. Again, it appears she is leading, as a way to negotiate her participation in the community of practice. By sharing and working with other ATPs to build a shared repertoire, Jennings was peer selected as a leader they could learn from. In some ways, Jennings positioned herself in this way within the community, which is not surprising considering her experience as a math coach in her district, a role that was made possible by her release time. In some ways, she entered the community of practice with a level of confidence in her ability to support the work of others, which was also one of the reasons she wanted to participate in the project. It is also interesting to note that some of the ATPs' nodes including Jennings' (DJ) are becoming larger than the project leadership (the green RTP square and the PIMSER Triangle). The interactions on the sociogram exemplify the *active phase* of the CoP.

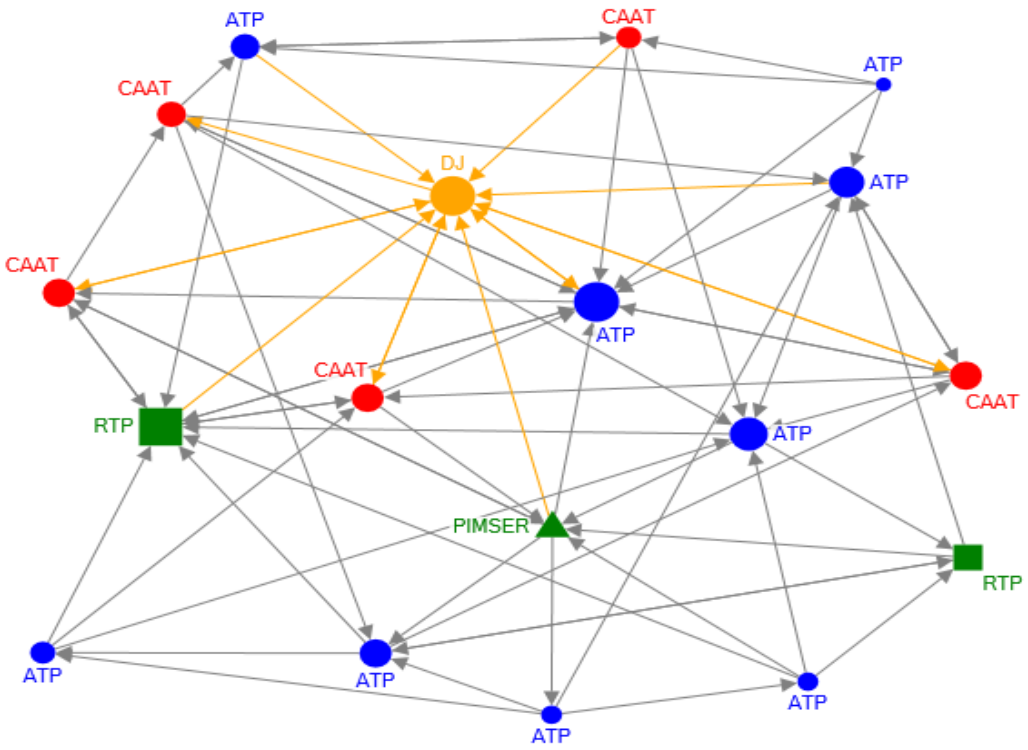


Figure 9. Relationships with those who participants view as a source for teaching ideas

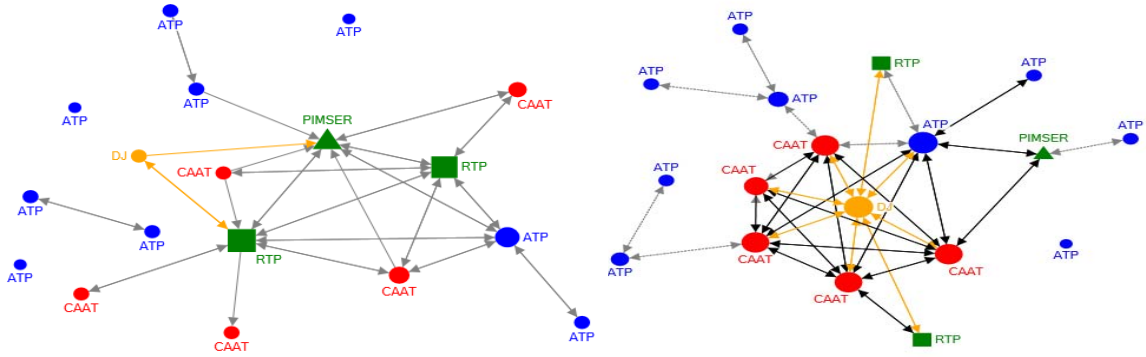
Sociogram C: Demonstrating Increased Interaction in the Intellectual Partnership

The question used for the Sociogram C prompt was, "Which persons do you consider to be collaborators (collaboration means actively working together to solve a problem, complete a task, or engage in some kind of project) during the past year?"

Respondents were also asked to indicate the extent of the collaboration for each person. The solid lines in this diagram represent a person with whom close collaboration occurred, and the dotted lines indicate only occasional collaboration. The data show that the *Peer CoP*, of which Danielle was an integral part, formed from within the larger project, as depicted by the larger nodes and the number of connections linking them. The data show that by the end of the project, Jennings identified all six of her *Peer CoP* as the individuals with whom she had collaborated the most. They reciprocated and chose her as

well, creating the tight web of solid lines with arrows within the *Peer CoP*. As a result, this group of *intellectual partners* have the largest nodes. The further development of this community may have been influenced by their participation in the CAAT project, which overlapped with the last year of the ATPP. However, one of Jennings' close collaborators was not part of the CAAT project.

By comparing the interactions at the beginning of the project with those at the end of the project, as shown in Figure X, the data indicate that Jennings and six other teachers formed a *Peer CoP* that emerged organically from within the larger group. Members of the *Peer CoP* self-reported that they monitored and reinforced each other's improvement efforts, defining them as a *legitimate* Community of Practice. Note that larger nodes and the web of arrows among these six and Jennings and the diminished interactions and node size for the project leadership at the end as designed by the green boxes and triangle. This group of six had the most influence on Jennings' classroom practice and became her *intellectual partnership group* that helped to create a shared repertoire consisting of numerous tools and strategies that she implemented in her classroom. Her *Peer CoP*, educational experts, and her students provided feedback to Danielle, which strengthened her implementation. This will be explored further as part of research question 3.



Danielle Jennings Relationships March 2009 Danielle Jennings Relationships December 2013

Figure 10. Comparison of Danielle Jennings relationships at the beginning and at the end of the project.

Research Question 2: How did the kinds of participation in which Jennings chose to engage affect her professionally?

Ethos, Interactive Professionalism and Participation

Honest, interactive professionalism emerged as an ethos—or guiding belief—that characterized Danielle's participation, especially during the Active Phase of her collaborations within the *Peer CoP*. When Jennings talks about the knowledge she gained from participating in the ATPP, she highlighted the importance of the *ethos* of the interactive professionalism in relation to the *nature* of her participation.

> We were able to share honestly and openly with the group our successes and failure alike and seek the advice from those we came to trust the most. The collegiality gave us the confidence to just "have a go," and we knew that our experiences would be valued by the group (D. Jennings, exchange, April 2014).

For Danielle, the "new" learning was constantly interpreted in terms of the realities of her classroom experiences. Almost all project sessions were dominated by teacher talk, which was encouraged and enhanced through the use of their shared repertoire, including (1) modeling and use of protocols, tools, and strategies for active engagement; (2) activities and feedback involving randomly selected groups and partners; and (3) whole group discussion. Teachers regularly brought their personal classroom experiences into discussions as resources so that everyone could benefit. This grounding of the "new" in the realities of teaching was complemented by the ongoing implementation of ideas that were introduced and practiced during the monthly meetings in teachers' classrooms.

Experience and Competence

In his *Community of Practice*, Wenger (1998) discusses why "the two-way interaction of *experience* and *competence* is crucial to the evolution of practice. In this interaction lies the potential for a transformation of both, and thus for learning, individually and collectively" (p.139). Wenger contends that when competence and experience are in conflict with each other, then classrooms can have teachers who are experienced but who do not necessarily know how to meet the learning needs of their students. Experience and competence should be in constant *tension* with one another, pulling with equal strength as one develops professionally in a CoP.

As a result of her participation in the *Peer CoP***,** Danielle's competence became more in sync with her years of experience. Danielle entered the ATPP with 20 years of teaching experience, 18 at the same high school. She had also served as an adjunct professor for Eastern Kentucky University. Jennings clearly had subject matter knowledge from her extensive coursework in mathematics and her years of teaching experience. "I felt pretty secure content-wise. I just didn't have—there was no source of person in my district to push me to any different level. I was just satisfied doing an okay job at a very poor school," Jennings said (Zeidler-Watters, personal communication, 2014).

Disciplinary knowledge is one of the competencies needed to be an effective teacher, but it is not all that is required. Teachers must also continue to develop their "mathematics knowledge for teaching" (Ball, 2003). Pedagogical content knowledge was a stated goal on Danielle's ATPP application. In a reflection from 2012, Danielle wrote:

I was fortunate to be involved in the project that confronted my belief system and challenged me to step out of my comfort zone. I was able to experience job embedded

professional development opportunities that focused on creating balanced assessment in my classroom and meeting the individual needs of the students in my classroom. I realized that I had to be more thoughtful and intentional in my planning and began to "facilitate" learning instead of just teaching (D. Jennings, self-reflection, Spring 2012).

Classroom Observation and Participation

Wagner (2004) says that our "classroom performances are rarely critiqued by others" (p.40) who know our content and pedagogy and have the ability to provide feedback that can improve student learning. This was not the case in the Appalachian Teacher Partner Project (ATPP), where observations of and feedback to the participants were routine. This feedback helped Danielle Jennings reflect and improve on her practice. Indeed, Jennings said that the observation of her classroom by ATPP project leadership was invaluable. "It was the first time in 20 years of teaching that someone with knowledge of my content and pedagogy, and who could provide meaningful feedback to strengthen my practice, had observed me" (D. Jennings, 2015).

The classroom observations were completed by Regional Teacher Partners (RTPs) who were part of a previously funded NSF project similar to the ATPP and who served as part of the ATPP leadership team. The RTPs were former secondary mathematics teachers who had extensive knowledge of high quality teaching and learning in mathematics and were in a position to provide quality feedback and facilitate conversations with Jennings about her practice. "This was a new experience for me. My own experience up until the project consisted of a few short observations from principals for evaluation purposes with limited to no feedback" (D. Jennings, 2014). Jennings shares,

> The classroom observations were critical to developing and fostering confidence in implementing new strategies. We were able to pre-conference through email and our pre-observation questions so that we were able to thoughtfully and intentionally plan rich lessons that would incorporate characteristics of highly effective teaching. The observations were informal, and we were able to conference afterwards to reflect. The reflection questions were carefully selected to engage each of us in meta-cognition…In our project, I was able to confide in math specialists that I respected. I felt a sense of responsibility to the project to implement the strategies from our trainings and from the conferences I was able to attend. I valued their feedback and used each observation to reflect upon my own growth and the learning taking place in my classroom (D. Jennings, 2014).

Changed Vision and Personal Identity

Significant changes in teaching practice consists of changing a teacher's beliefs, teaching style, and materials, which can occur only through a process of personal development in a social context (Fullan, 1991). Over time, Jennings engaged in a participatory process of personal development with support from the *Peer Community of Practice*, which allowed her to reflect on her teaching practice and how students learn. Jennings stated,

> I began to realize that I could not control all of the things that can affect learning in the school, such as time, money, and lower poverty rates. I realized that most of the things the project was asking me to think about was within my realm of control, or in my boat. The things that were within my control included classroom culture and the use of effective tools and strategies for a variety of instructional purposes such

> as engagement, differentiation, reflection, practice, uncovering prior knowledge, reviewing, student peer and self- assessment, and feedback (D. Jennings, PowerPoint, 2013).

Her reflection also shifted the way in which she viewed her students and what was needed to support their learning of rigorous content. Jennings shares the outcome of a conversation she had with some of her *Peer CoP* about the ATPP project,

> We [ATPs] didn't realize the potential inside of ourselves and the potential inside our students until we had gone through the project. Getting to see some of the brain research and that whole idea of allowing students to make mistakes that is where that core learning is going to happen for them. So just really allowing my students to feel disequilibrium in the classroom. I never allowed that before (Zeidler-Watters, personal communication, 2014).

These personal insights developed as a result of Jennings' interaction, some of which she initiated, with the Community of Practice, through mutual engagement and creation of a shared repertoire.

Transformative Practice: Being and Becoming

The change in Jennings' practice was *transformative* and is ongoing. It involves both "being and becoming" that at any point in time can be experienced as a product of learning, according to Wenger (2008). Her personal transition involved studying new standards and planning a unit of study to address a known student need; developing confidence in her ability to work in partnership with known educational experts; differentiating instruction to meet individualized student learning needs; assessing and providing feedback on student learning and involving the student in self-assessing and

goal setting; and accepting that part of the profession is continuing to learn as part of "being and becoming" an expert mathematics teacher.

In Year 3 of the project, Jennings attended an ASCD Institute in California on "habits of mind" and innovation of education professor Art Costa. Jennings and the other project representative, selected to attend the institute, then were tasked with bringing the learning their newfound learning back to share with the other ATPs. Jennings reported that this experience played a primary role in her becoming a better teacher. Jennings shares,

> I knew about the habits of mind from the coaching training that I received from the Kentucky Center for Mathematics. I had applied the habits of mind as a coach with teachers and had not thought about its application to improving student learning until I attended additional training as part of a two-day ASCD Institute on Habits of Mind. I immediately saw the application to the classroom (Zeidler-Watters, personal communication, 2014).

The ASCD two-day institute in January of 2010 was led by Bena Kallick who had recently co-authored a book on the habits of mind with Costa. However, Jennings shares that in a completely unexpected event, while participating in the session with Kallick, she had an opportunity to work with Costa. "Art Costa walked into the room and my mouth fell open. When he sat at our table I was just like—I was in disbelief. The only reason I recognized him is because I had watched a video clip of him speaking online" (Zeidler-Watters, personal communication, 2014). Jennings engaged intellectually with Costa as he joined their small group as a participant in the session. Jennings shares,

> We were discussing meta-cognition. He sat down and I can remember how he was using probing questions and his own strategies to get us to open up and move the

> conversation. You could hear the deep level of his consciousness within the questions he poised. He wanted to challenge us with ideas we had never thought about before. He was training us to learn how to be more reflective in our nature and use our reflections and observations to think deeply about how we should respond. There are some things (without consciousness that you just don't really think about enough). It is important to know how you feel and what characteristics you can grow to enable yourself to handle challenges. This affected me at both a personal and professional level (D. Jennings, April 2015).

Working with and learning from the experts validated and deepened what Jennings already knew and provided her insight into the role the habits of mind (HoM) can play in promoting student learning. This professional and intellectual learning experience had a profound effect on the way Jennings applied the habits of mind.

Specifically, Danielle continued to make meaning, through reflection, as she revisited the HoM materials that she had received from both the coaching training and from the ASCD Institute. She worked with one of her *Peer CoP* members, Fran, who had also attended the HoM session, to develop a tool based on the habits of mind that would help students confront challenging problems. "Together, Fran and I created a five-finger mnemonic tool that distills the 16 habits of mind into five states of mind: efficacy, consciousness, craftsmanship, flexibility, and interdependence, that we agreed to implement with our students" (Zeidler-Watters, personal communication, 2014).

Jennings said,

> Fran and I developed an analogy for students so they would know how to respond when faced with a challenge. We used the video of the airline pilot Sully

> Sullenberger, landing a plane on the Hudson River as a way to introduce the HoM. We decided that we could have students examine and discuss how Sully responded to the challenge he faced and what helped him to be successful in meeting the challenge (Zeidler-Watters, personal communication, 2014).

Jennings and Fran later shared with other ATPs the knowledge and skills they had gained in the ASCD HoM session. The experience of sharing her knowledge on habits of mind with other Appalachian Teacher Partners (ATPs) and working to develop the HoM mnemonic tool allowed Jennings to realize that the classroom learning climate and learning community are critical.

> I had not thought about the importance of community within the classroom. I was covering content not building a community of learners who can support each other. I was leading them. I think that layer was going on with us as ATPs also, we were all realizing that we were working on building a community because we were just good teachers working in isolation," Jennings said (Zeidler-Watters, personal communication, 2014).

Through the development of the shared repertoire and her engagement in intellectual partnerships, two dimensions of Jennings' "participation," she was prepared to implement the knowledge she had gained through her experiences. She did this by extending the community of practice insights into her classroom practice (see Question #3 below). With time, other practices and activities emerged as important features of the shared repertoire of Jennings' *Peer Community of Practice*, such as sharing struggles and celebrating successes, sharing teaching resources, and commenting on and providing feedback on tools and resources.

Dispersed Stage: Jennings's *Peer Community of Practice* Disperses

A later stage of development of a CoP as identified by, Wenger et al. (2002) is "dispersed". During this stage, "the members no longer engage very intensely, but the community is still alive as a force and a center of knowledge" (p.6). Wenger identified some typical activities that occur as CoPs enter this stage such as "stay[ing] in touch, communicating, holding reunions and calling each other for advice". Although Jennings Peer CoP is now dispersed, the participants continue to stay in touch and support each other professionally, even though they are not meeting regularly and the project has ended. The impact of Jennings' participation remains in her classroom today as evidenced by the sustained student learning results discussed in Research Question 3.

Research Question 3: How did her participation affect her classroom practice?

Orchestrating Instruction

Coming into the project Jennings had a deep conceptual understanding of the discipline of mathematics. It was during the project that she developed her "mathematics knowledge for teaching" (Ball 2003). The tension between experience and her elevated competence allowed her to modify her teaching and assessments, which in turn led to sound judgments that benefitted all the learners in her classroom. Her engagement with the intellectual partnerships resulted in legitimate participation with both her *Peer CoP* and extended to external opportunities with educational experts. These experiences provided Jennings processes, tools and strategies to change how she orchestrated instruction. She took the notions of intellectual partnerships, truly legitimate participation, and shared repertoire back to her classroom and worked to orchestrate these with her students to improve their learning of rigorous mathematics content required as part of an Advanced Placement calculus course.

Transformative Changes are Impacting Student Learning

Jennings had been teaching AP calculus for three years when she began the Appalachian Teacher Partner Project (ATPP) in 2008. "At the time, I was happy just to introduce students to calculus, and few students would pass the exam," Jennings said (Zeidler-Watters, personal communication, 2104). Student learning results in AP had not changed significantly from what they were when she started teaching the class in 2005. Both the multiple choice and free response scores were significantly below the global mean as shown in Figure 11 below. More specifically, of the 16 students enrolled in the 2009-2010 class (Mrs. Jennings' first year in the project), one scored a 3 on the exam, and the average score on the multiple-choice section was 1.188. According to the College Board, the score of 3 means that a student is "qualified" and has proven himself or herself capable of introductory-level course work in that particular subject at college. Many colleges and universities grant credit and placement for scores of 3, 4 or 5, but the score each individual institution will accept is an independent decision.

Score	**1**	**2**	**3**	**4**	**5**		**Global Mean**	**Group Mean**
# of Students	14	1	1	0	0	Multiple Choice Summary	21.4	6.4
						Free Response Summary	17	6.6

Figure 11: Jennings Students 2010 AP Calculus Test Results

The school has an open enrollment policy in Advanced Placement classes, which requires that all students enrolled in AP calculus take the AP exam. Jennings said, “There were no exceptions to this policy. Many students had to pay for a test that they were just not prepared for” (D. Jennings,AP Progress PowerPoint, 2013).

Test results for Jennings’ AP calculus class dramatically improved after her participation in the ATPP. Her students surpassed the global mean on both the multiple choice and free response portions of the exam during the 2010-2011 school year, as shown in Figure 12.

Score	1	2	3	4	5		Global Mean	Group Mean
# of Students	2	3	8	3	2	Multiple Choice Summary	27.6	29.1
						Free Response Summary	17.8	19.9

Figure 12. Jennings Student 2011 AP Calculus Test Results

The average score on the multiple choice section increased from 6.4 in 2010 to 29.1 in 2011, surpassing the global mean of 27.6. Also in 2011, the student group mean on the free response was 19.9 (compared to 6.6 in 2010), which surpassed the global mean. Additionally, thirteen of Jennings’ students scored a passing score of a 3 or higher on the exam compared to the year before when only one of the sixteen students enrolled in the course scored a 3 or above (see Figure 13).

As a result of the dramatic gains in just one year, Mrs. Jennings began to work with the other teachers in her department on vertical alignment between the high school curriculum and the middle school curriculum. She shared strategies so that more students would have the opportunity to be successful in mathematics and have the prerequisite skills to be successful with the AP curriculum.

Exam Year	# of Students enrolled	# of students scoring 3	# of students scoring 4	# of students scoring 5
2010	16	1	0	0
2011	18	8	3	2
2012	15	3	3	2
2013	15	3	3	2
2014	22	7	2	4

Figure 13. Jennings's 2010 compared to 2011 AP Test Results

The positive results continued to be sustained as the data show in the Figure 13 and demonstrate that Jennings is a teacher who is able to help students learn rigorous content. Jennings said that,

> 2012 and 2013 were both transition years, because juniors were offered AB Calculus for the first time. Five of the students were juniors, 4/5 were successful with scores of 4 or 5. In 2013 Brooke County High School offered BC Calculus for

the first time, and five students took that offering so AB numbers were lower (D. Jennings, PowerPoint presentation, 2013).

During 2014, the scores of Jennings' students' met or surpassed the global mean on both multiple choice and the free response summary (see Figure 14).

	Global Mean	Group Mean
Multiple Choice Summary	26	26
Free Response Summary	19.3	19.9

Figure 14. Jennings 2014 AP Test Results

Participation and Transformative Practice

Another way Jennings negotiated her ongoing participation in the CoP was through her teaching process that was transforming her classroom. Jennings took her knowledge of how her *Peer CoP* was affecting her professionally and transferred the idea to create a community of learners among her students. Jennings enacted the shared repertoire in her classroom practice with her students. The students were no longer passive learners waiting for direction and answers from the teacher. They were becoming intimately involved in providing input into the decisions of the classroom experiences that promoted their learning. "Ms. Jennings listens to what we have to say and wants our feedback," said one student (Zeidler-Watters, student personal communication, 2013).

As Jennings interacted with her students in class by practicing strategies and asking for their feedback, opportunities arose for her to learn as well. Accordingly, her belief about the role she played in orchestrating an effective learning environment for her students became clear. Several comments she made during the follow-up interview (2014) reflect these changes.

> I realize that I had to be more thoughtful and intentional in planning for learning instead of just teaching. Nothing was left to chance. I wanted their feedback on how this was different from other things that they typically do in the classroom and how this was helping their learning.

Jennings reported that the students noticed and would often say, "You are really doing something different here" (Zeidler-Watters, personal communication, 2014).

Culture of Learning

> It is not just about the content or everybody let's work this problem. It all starts with your learning climate—the learning community. Before the ATPP, I was covering content not building a community of learners who can support each other. I was leading them. I think this was going on with us as ATPs, we were working on building a community because we were just good teachers working in isolation. I wanted that same collegiality to transpire similarly in my classroom (Zeidler-Watters, personal communication, 2014).

Jennings participation in the ATPP and her interactions with her *Peer CoP* provided her with ideas on how to build a learning community in her classroom. Her students served as the vehicles to help Jennings negotiate meaning about what makes a difference in student learning. The success of her students also elevated her confidence

level and validated the professional experiences developed in partnership with her *Peer CoP*.

Initially she began to change her classroom culture by purposefully deepening her students' understanding of the habits of mind through the use of the five finger mnemonic. Jennings shares how she begins this process,

> I confront my students immediately first about their efficacy of how they feel about being in the classroom. For some of them it may be the first time they are in a college class, may be the first time they are in an AP class. Do they feel that their effort can make a difference? I want them to monitor their efficacy as they go along. I want them to know how to behave when confronted with a problem they don't understand (Zeidler-Watters, personal communication, 2013).

According to the classroom observations, interviews with Danielle, and student interview data, the HoM became a part of the daily routine of the classroom. She said, "I can see how the habits of mind need to be built into the curriculum and how that needs to be part of the language of the classroom, so that is something that I started making a real conscious effort to do" (Zeidler-Watters, personal communication, 2014, year). She also shared, "The habits of mind are a learning strategy. That's as important as the content you're teaching" (Zeidler-Watters, personal communication, 2013).

One of the classroom observers noted that "she uses the five-fingers-on-one-hand memory device, and I get the impression that rare would be the day that at least one of them is not mentioned in the class" (JM, classroom observation, 2014). One of Jennings' students shared,

> Mrs. Jennings creates a really good atmosphere in her class that makes me feel really comfortable with learning because in her class, it's not about the grade at all so I don't have to stress myself out over like a sheet of homework or a test. I know it's not about the grade, she cares if I learn or not…she cares about if you put forth effort and learn. That makes me really comfortable in her class (Zeidler-Watters, student personal communication, 2013).

Another student shared,

> For the states of mind, she wants us to be real flexible, and she wants to make sure that we can give her answers in multiple ways and that if we're not comfortable giving an algebraic response, she'll ask you for a graphical response, or a numerical response, or even in a sentence as some questions need (Zeidler-Watters, student personal communication, Spring 2013).

Jennings referred to these multiple ways of representing a problem as the NAGS rule (numeric, algebraic, graphic and sentence), which she saw in action when she observed, Shelby, another ATP in her classroom. She recalls,

> I completed a Math Curriculum Topics Study on multiple representations as part of the unit I was developing through the ATP project. I always felt like I valued representations in the classroom. However, after seeing Shelby [who was part of Jennings *Peer CoP]* in her classroom where she had the big N-A-G-S on the board and that being a common practice in their mathematics department, I really started to tap into that and I thought, you know what, that makes a big difference. If I stick to my textbook unit, this way of thinking about problems doesn't even exist in this

book. So I really drew on that in the unit I was developing, I chose the derivative of derivative testing and I really focused on NAGS. Then when I got the data at the end of the year, when I could see absolute, no question, and the absolute significant impact on student understanding, it was like, oh my goodness, why aren't we taking more time to do this type of planning? (Zeidler-Watters, personal communication, 2014).

Figure 15, shows the improvement in her students' understanding after she taught the unit of study developed as part of the intellectual partnership experience with Harvey Silver.

AP Calculus Test, Open Response Question #4 Graphical Analysis of g and g' or analysis of a function	**Global Mean**	**CCHS Mean**
2009-2010	1.7	.5
2010-2011 Note: year Jennings taught the unit of study developed as part of her participation in the ATPP	2.4	3.3

Figure 15. Jennings AP Students Results on the same concept before and after unit implementation.

It is clear from all eight of the students that were interviewed that Jennings was building a shared repertoire with her students that would help them improve their learning. This was an area of her practice that she felt was within her control, and therefore, she willingly put forth an effort to improve it. By orchestrating a culture of learning, Jennings noticed that her students were "taking ownership of their own learning!" (Zeidler-Watters, personal communication, 2014).

Transformative Learning through Formative Assessment

Jennings continued to help students further develop a shared repertoire of their own. One way she did this was through involving her students in self-assessment and goal setting. These tools and strategies helped the students to focus and be able to better understand and communicate their learning needs. The data allowed Jennings to better understand her student's individual needs so she could better support their learning.

One example that she used to help students be clear about the learning journey was the unit test plan, which served as a roadmap from the beginning of the unit. Jennings applied what she had learned through the ongoing study of the *Classroom Assessment for Student Learning* work to create a test plan that includes the learning goals or targets for the unit and individual lessons to the unit development framework of Harvey Silver. The fact that she took a strategy from one source and amended another (unit framework) is evidence of her increased confidence and competence. The targets (K=knowledge and R= reasoning) would be used by students throughout the unit to collect data so they could self-assess, determine their strengths and weaknesses, and set goals for improving. Figure 16 shows an example of one of Jennings' test plans for the calculus concept of implicit differentiation.

Test Plan: Implicit Differentiation

Learning Target	Target Type	Number of Questions
I can use implicit differentiation to find the derivative of a function.	K	5
I can find dy/dx by implicit differentiation and evaluate the derivative at the indicated point.	K	2
I can find the 2nd derivative in terms of x and y using implicit differentiation.	K	2
I can find equations for the tangent and normal line to the graph at the indicated point.	R	1
I can find dy/dx using both implicit and explicit methods and evaluate at a given point.	R	1
Open Response: I can use implicit differentiation to find the derivative of a function. I can find a point P which the line tangent to the curve at P is horizontal.	R	1

Figure 16. Jennings' Test Plan Example

During her 2014 follow-up interview, Jennings shared,

> I had never pre-assessed students before. Building a quality pre-assessment was one of the first things I did when I developed my unit for the project. It was very short, but I remember how much thought I put into building it and how much information I gained about my students from the three questions.

The sample pre-assessment that was shared by Jennings (see Figure 17) shows in the "note" that she pre-identified what she was going to be looking for in the resulting student

work, so she could then utilize her repertoire to identify experiences to help her students learn.

Pre-Assessment
Derivative Testing Unit

1. **Given f(x) = $2x^3 - 3x^2 - 11x + 6$**

a. Find f'(x)

b. Find the zeros of f'(x)

c. Find f"(x)

d. Find the zeros of f"(x)

2. **Given f(x) = $\frac{2x+1}{x-2}$**

a. Find f'(x)

b. Find the zeros of f'(x)

c. Find f"(x)

d. Find the zeros of f"(x)

3. **Given f(x) = 3sinx**

a. Find f'(x)

b. Find the zeros of f'(x) on the interval [0,2π]

c. Find f"(x)

d. Find the zeros of f"(x) on the interval [0,2π]

Note to self: I want students to be able to find the derivatives of polynomials as well as rational and trigonometric functions. The vocabulary word "zero" is something I am looking at. I did my Math Curriculum Topics Study on multiple representations and there are other representations for the word zero (x-intercept, root, solutions). I am checking their meaning of this term and I want to see which method they use in finding the zeros. Finding the zeros will be essential in finding the critical values. I am also assessing their calculator dependency on each type of function.

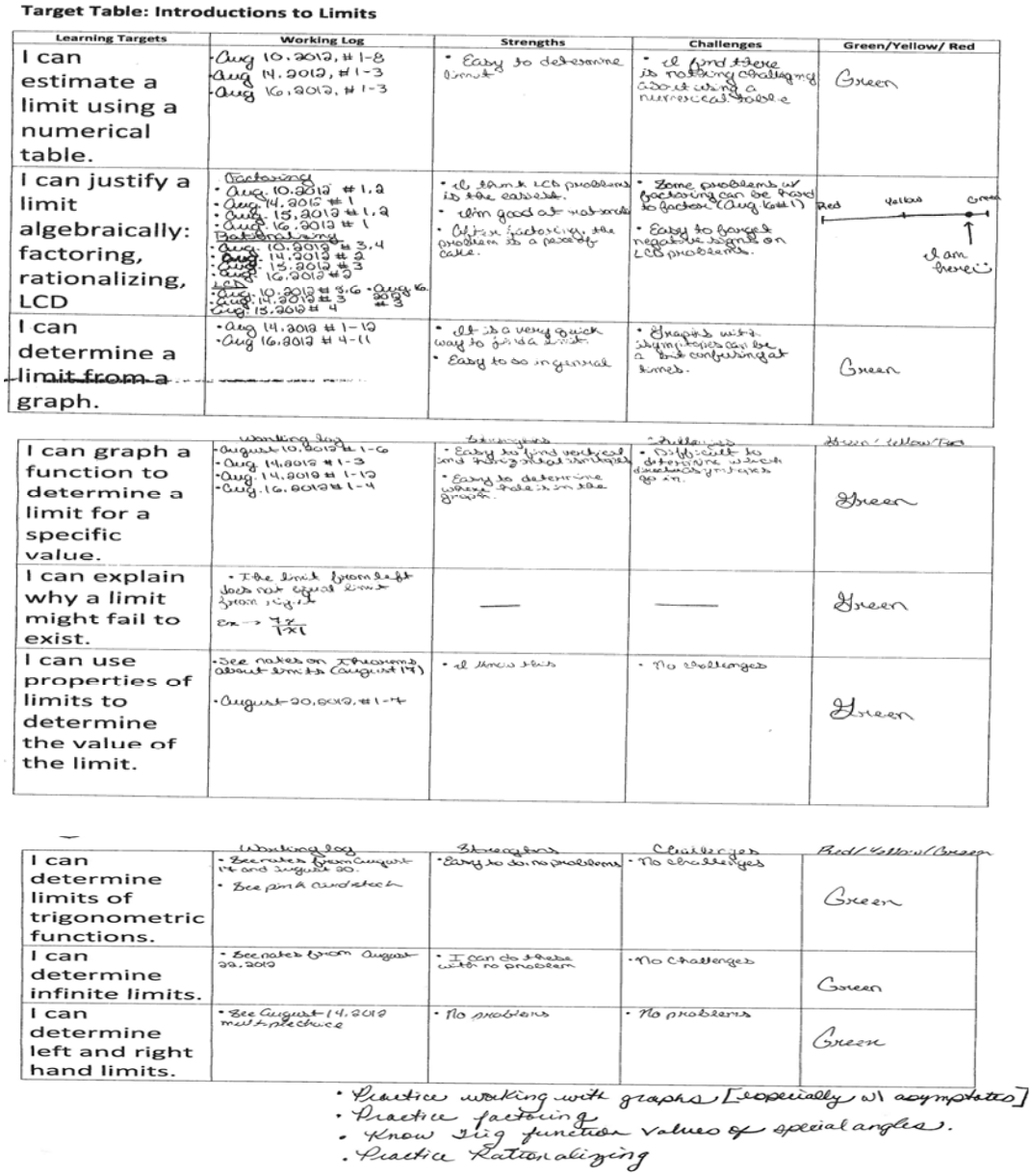
Figure 17. Jennings Pre-Assessment Example

Danielle's students attest to the value of intentional planning especially as it relates to assessment. One student commented, "Helping me with the targets I don't understand is far more important than copying for a good grade. How do you know that you know? That's a great question" (Zeidler-Watters, student personal communication, 2013). Another student shared, "This year has really filled in all the gaps from freshman and sophomore year. Instead of just memorizing formulas, we talk about how and why they work, and it makes much more sense" (Zeidler-Watters, student personal communication, 2013).

Another tool that Jennings used with her students was a target table to help them identify specific targets they were going to learn. It also provided specific examples the students could use to study the mathematics content (see Figure 18). One student commented on the value of the target tool,

> One of the major tools that Mrs. Jennings gives us in order to self-reflect and keep track of our progress is a target table (see Figure 18). Basically, she'll give us a target and state like I can do limits for example, or I can do a derivative. Then we will have specific targets and in those targets we will have different columns like we will do an example of the problem and then we will write down other examples in our notebooks so we can look back and see the examples. Then at the end it states whether we are good at it or not. We have to say how comfortable we are with each target. We use red, yellow and green. Green means you're really good with it. Red means you're not that good and yellow means you are in the middle. I think that really helps because when you go back and study it, you'll know the red ones are the ones that you really need to study. So you won't spend all of your time

studying something you already know (Zeidler-Watters, A.G. personal communication, 2013).



Target Table: Introductions to Limits

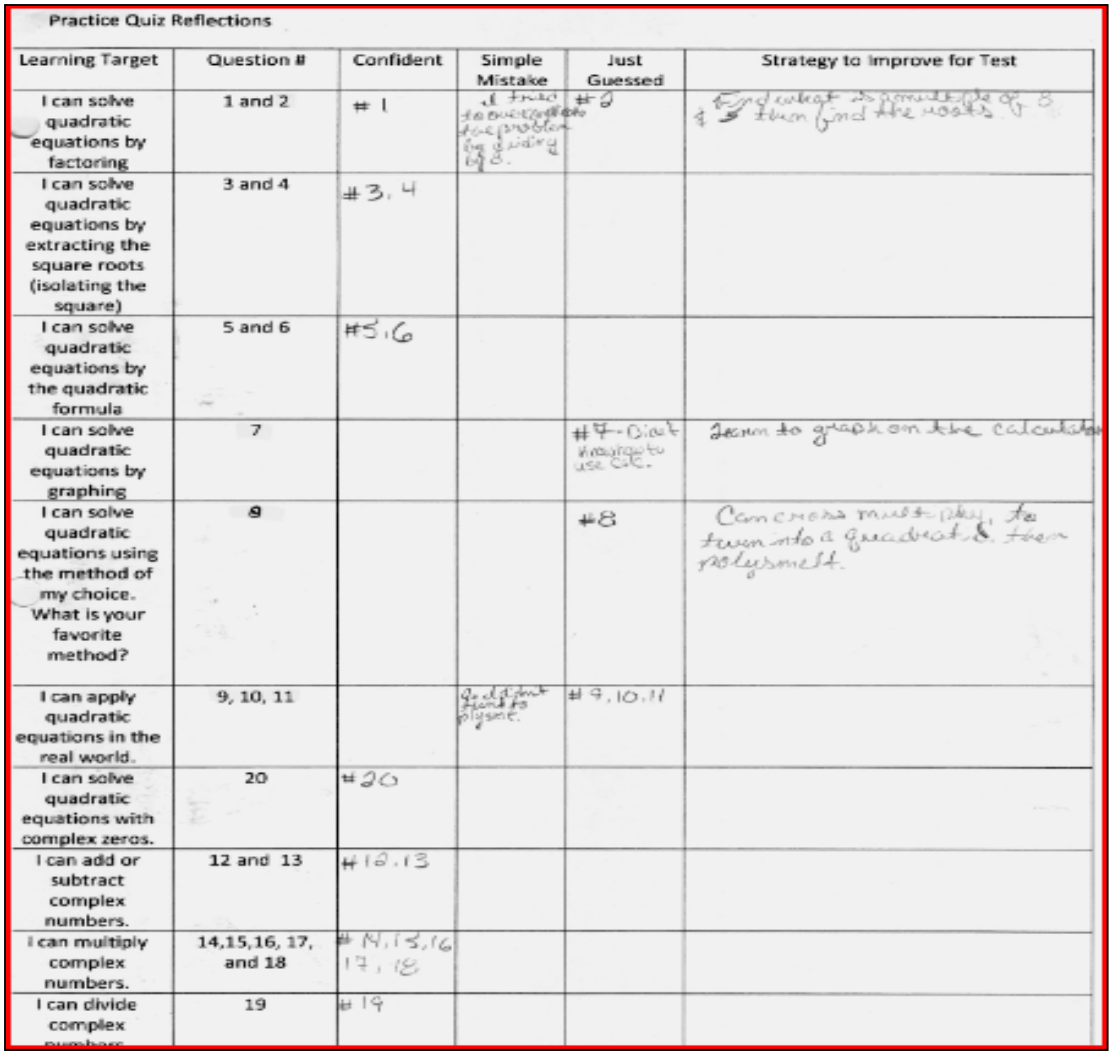
Learning Targets	Working Log	Strengths	Challenges	Green/Yellow/ Red
I can estimate a limit using a numerical table.	• Aug 10, 2012, # 1-8 • Aug 14, 2012, # 1-3 • Aug 16, 2012, # 1-3	• Easy to determine limit	• I find there is nothing challenging about using a numerical table	Green
I can justify a limit algebraically: factoring, rationalizing, LCD	Factoring • Aug. 10, 2012 # 1, 2 • Aug. 14, 2012 # 1 • Aug. 15, 2012 # 1, 2 • Aug. 16, 2012 # 1 Rationalizing • Aug. 10, 2012 # 3, 4 • Aug. 14, 2012 # 2 • Aug. 15, 2012 # 3 • Aug. 16, 2012 # 2 LCD • Aug. 10, 2012 # 5, 6 • Aug 16, 2012 # 3 • Aug. 14, 2012 # 3 Aug. 15, 2012 # 4	• I think LCD problems is the easiest. • I'm good at factoring • After factoring, the problem is a piece of cake.	• Some problems w/ factoring can be hard to factor (Aug 16 #1) • Easy to forget negative signs on LCD problems.	Red Yellow Green I am here
I can determine a limit from a graph.	• Aug 14, 2012 # 1-12 • Aug 16, 2012 # 4-11	• It is a very quick way to find a limit. • Easy to do in general	• Graphs with asymptotes can be a bit confusing at times.	Green
I can graph a function to determine a limit for a specific value.	• August 10, 2012 # 1-6 • Aug 14, 2012 # 1-3 • Aug 14, 2012 # 1-12 • Aug 16, 2012 # 1-4	• Easy to find vertical and horizontal asymptotes • Easy to determine where hole is on the graph.	• Difficult to determine which direction y-values go +/-	Green
I can explain why a limit might fail to exist.	• The limit from left does not equal limit from right Ex → $\frac{7}{1-1}$	—	—	Green
I can use properties of limits to determine the value of the limit.	• See notes on Theorems about limits (August 14) • August 20, 2012, # 1-7	• I think I have it	• No challenges	Green
I can determine limits of trigonometric functions.	• See notes from August 14 and August 20. • See pin A and check	• Easy to do, no problems	• No challenges	Green
I can determine infinite limits.	• See notes from August 22, 2012	• I can do these with no problem	• No challenges	Green
I can determine left and right hand limits.	• See August 14, 2012 multiple choice	• No problems	• No problems	Green

• Practice working with graphs [especially w/ asymptotes]
• Practice factoring
• Know trig function values of special angles.
• Practice Rationalizing

Figure 18. Jennings Target Table Example

Jennings also used another tool--*learning checks*--with her students (see Figure 20) as part of their developing repertoire of strategies, which helped her students take responsibility for assessing their own learning (see Figure 19). The student interviews revealed the kind of learning culture that had been developed. One student said it most powerfully, “It is not all about the grade in Mrs. Jennings’ classroom. It’s about the learning.” Jennings said,

> We do smaller learning checks in AP. Just the idea of this is a learning check, it is not a summative exam. This is a learning check for you to see where you are in your learning. The whole idea of really having students take responsibility for their learning and you can see if that switch went off, those were the kids that were progressing and achieving beyond (Zeidler-Watters, personal communication, 2014). Test corrections are an excellent learning tool. Students can now learn from the simple or complex mistakes made instead of repeating them (Zeidler-Watters, personal communication, 2013).



Practice Quiz Reflections

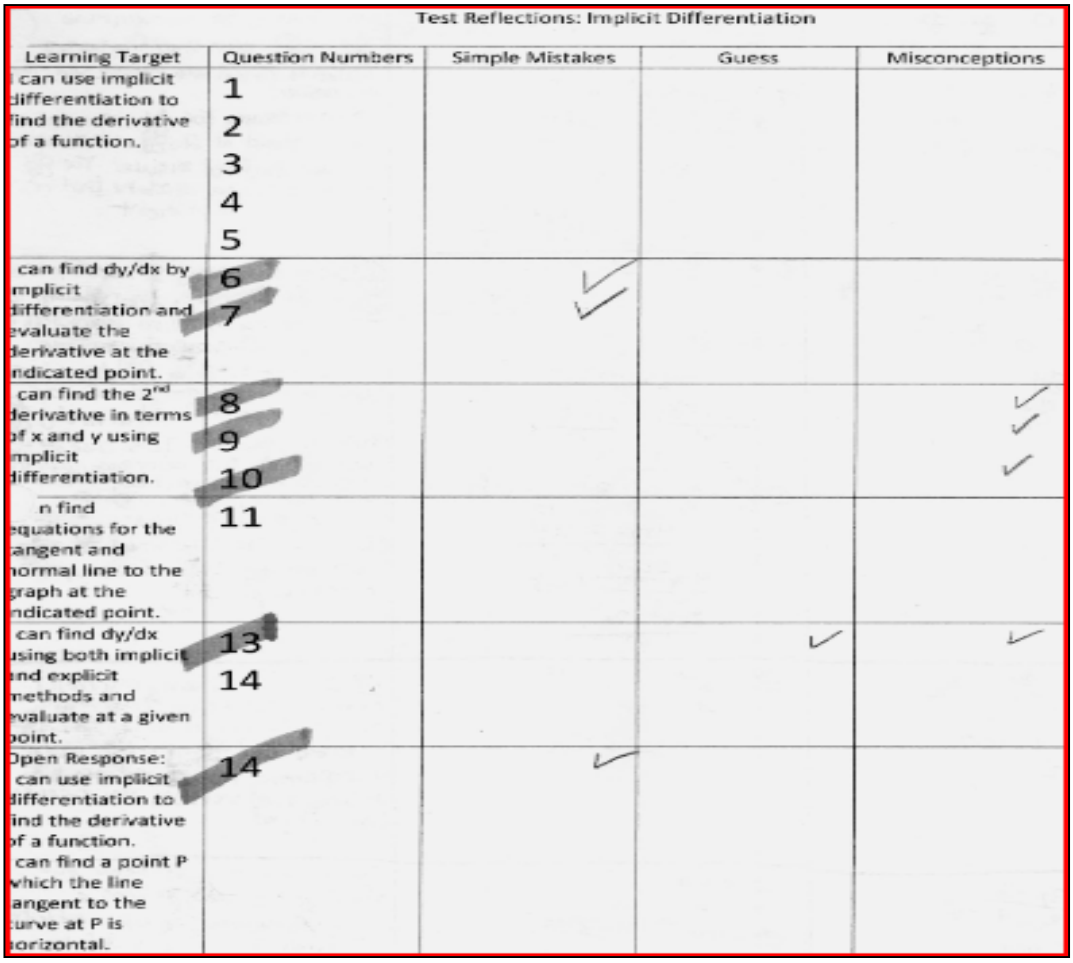
Learning Target	Question #	Confident	Simple Mistake	Just Guessed	Strategy to Improve for Test
I can solve quadratic equations by factoring	1 and 2	# 1	I tried to use the problem by guiding by 0.	#2	Find what 3 times 2 is 6 then find the roots of 3
I can solve quadratic equations by extracting the square roots (isolating the square)	3 and 4	#3, 4			
I can solve quadratic equations by the quadratic formula	5 and 6	#5, 6			
I can solve quadratic equations by graphing	7			#7- Didn't know how to use calc.	Learn to graph on the calculator
I can solve quadratic equations using the method of my choice. What is your favorite method?	8			#8	Can cross multiply, factor into a quadratic & then polynomial.
I can apply quadratic equations in the real world.	9, 10, 11		Didn't know how to begin.	#9, 10, 11	
I can solve quadratic equations with complex zeros.	20	#20			
I can add or subtract complex numbers.	12 and 13	#12, 13			
I can multiply complex numbers.	14,15,16, 17, and 18	#14, 15, 16, 17, 18			
I can divide complex numbers	19	#19			

Figure 19. Jennings Sample Learning Check with Student Test Correction

One of Jennings students shared, "Math was never my best subject. I stress over tests in math. After using learning targets and analyzing the things I get and the things I don't, my stress level went down. Now I feel successful in math!" (Zeidler-Watters, student personal communication, 2013).

Additionally, Jennings used a test reflection sheet as part of the shared repertoire for FA which fosters metacognitive thinking by students (see Figures 20-21). Jennings explained,

Students are asked to complete a test reflection sheet at the end of each assessment (formative or summative (see Figure 21). I want to know in mathematical language, how they missed the problem. Students are allowed to re-test targets after completing the reflection assignment. I want testing to be more than a one-and-done experience for my students. I try to conference with students to discuss where they stand toward meeting benchmarks and work with them to develop strategies and/or actions so that they can improve their level of achievement. I find myself being more flexible in my own thinking and more thoughtful and intentional in my planning as I craft and weave the learning experiences in my classroom (reflection, Spring 2012).



Test Reflections: Implicit Differentiation

Learning Target	Question Numbers	Simple Mistakes	Guess	Misconceptions
I can use implicit differentiation to find the derivative of a function.	1 2 3 4 5			
I can find dy/dx by implicit differentiation and evaluate the derivative at the indicated point.	6 7	✓ ✓		
I can find the 2nd derivative in terms of x and y using implicit differentiation.	8 9 10			✓ ✓ ✓
I can find equations for the tangent and normal line to the graph at the indicated point.	11			
I can find dy/dx using both implicit and explicit methods and evaluate at a given point.	13 14		✓	✓
Open Response: I can use implicit differentiation to find the derivative of a function. I can find a point P which the line tangent to the curve at P is horizontal.	14	✓		

Figure 20. Student Example of Test Reflection

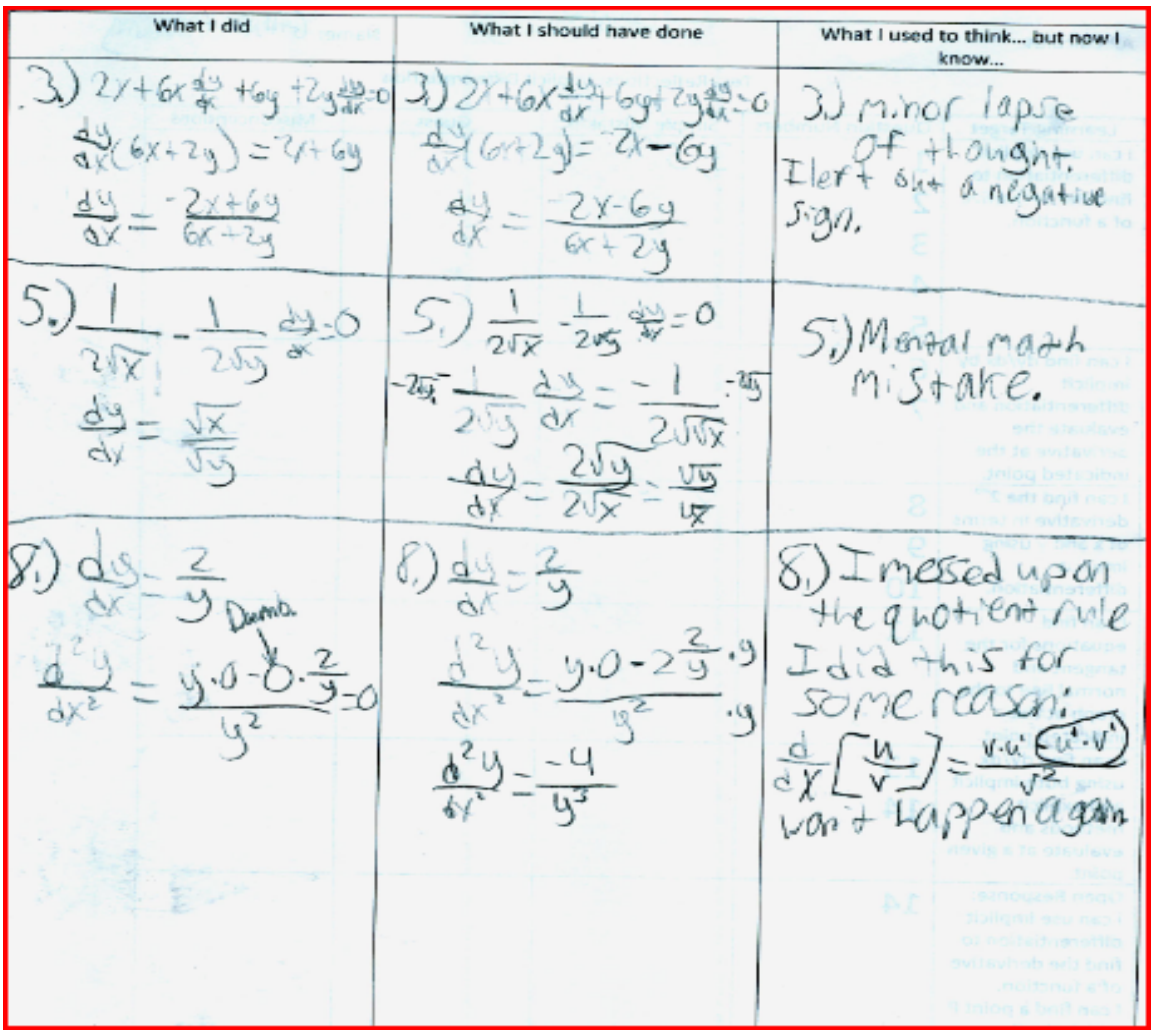


Figure 21. Sample Student Test Reflection

Jennings was proud to share that "by setting goals, using clear learning targets, reflecting on their own learning, self-assessing, and taking control of their own learning, my students have experienced significant gains in achievement" (Zeidler-Watters, personal communication, 2014). Jennings recognizes the power of this repertoire of strategies for informing her instructional decisions and for empowering her students.

Probably what makes my classroom most unique is wrapped around the feedback that I provide and that the students provide each other, and how the teacher

> communicates with the students that you are doing your best to create a community of learners and it is about the learning not the grading. The most wonderful component of the strategies is when you see the realization that the kids are starting to set goals and self-assess and become self-directed learners (Zeidler-Watters, personal communication, Spring 2013).

One of Jennings' students shares the impact this approach has had on her as a learner,

> I think Mrs. Jennings does a really good job of letting you learn the material through practice and not just focusing on the grade. She provides lots of feedback on our work. It's not like other classes where the teachers assign the work, collect it, and you never see it or use it again. I take the feedback and will use the internet because there are some really good resources that Mrs. Jennings has shown us to help improve our learning like Hippo Campus (Zeidler-Watters, student personal communication, 2014).

Jennings shared,

> The task rotation was one of the first things that I can remember implementing in my classroom. The kids really noticed, "You are really doing something different here."…I really wanted their feedback on how this was different from other things they typically do in a classroom (Zeidler-Watters, personal communication, 2014).

Figure 22, shows one of Jennings' sample task rotations. This structure supported the learners by allowing them to explore the concept through a variety of learning styles, pushing students beyond what they were comfortable with and allowing them to look at the concept in different ways.

Mastery	Interpersonal
Create a glossary of the vocabulary terms listed below. You can use words, pictures, numbers, and examples to define or illustrate each term. • Critical Value • Relative Extrema • Concavity • Point of Inflection	Partner Activity: Each partner creates a polynomial whose graph crosses the x-axis at least twice over the interval [-3,2]. Graph your polynomial on a graphing calculator. Without revealing the function, exchange graphs. Each partner will describe the characteristics of the derivative.
Understanding	**Self-Expressive**
Three Way Tie: Look at the triangle below. Write a sentence along each side of the triangle that connects the word or phrase at each angle of the triangle.	Create a graph that represents your growth as a math student over the course of this year. Identify critical values, extrema, discuss concavity, and find any points of inflection. Describe the significance of these characteristics as they relate to your experiences.

Figure 22. Jennings' Example Task Rotation

The significant pieces of the shared repertoire of tools (classroom culture, formative assessment and differentiation) was established through Jennings' *intellectual partnership* with both external educational experts and her internal *Peer CoP*. The repertoire that she created through engaging in these experiences is one that remains in Jennings' classroom today and exemplifies "mathematics knowledge for teaching" (Ball, 2003).

Summary of Themes and Findings

- Wenger's Stages of Development for a CoP was a useful methodology in documenting the development of a CoP for an experienced group of classroom teachers, such as Jennings and her Peer CoP. Considering how to get such a group

to recognize their potential, the factors involved in coalescing the community, and the ways that community might mutually engage in an action phase seem to be important in explaining why Jennings was able to negotiate participation and change.

- Danielle Jennings negotiated her participation through *intellectual* partnerships formed through the interaction with her *Peer CoP* and the educational experts and researchers--an example of a legitimate participation in authentic professional activities at a level quite different from most "teacher professional development" activities. The shared repertoire was tangible evidence which resulted from the ongoing interactions that Jennings had with her Peer CoP and educational experts in the field.
- Community of practice literature typically includes a mostly internal or organic development within a professional community. These findings indicate that a viable, robust CoP *can* be stimulated through external scaffolding and coordination of learning activities in combination with a joint enterprise of growth-minded professionals. The sequencing of the joint enterprise was scaffolded "externally" by policy, i.e., Senate Bill 1, and the adoption of Common Core Mathematics Standards. However, the Appalachian Teacher Partner Project developed organically over time into a shared repertoire with increasing ownership from Danielle Jennings and the other participants and decreasing influence from the project leadership team.
- Jennings participation was transformative in that it allowed her to enact the shared repertoire in her classroom practice. Mrs. Jennings' experience and competencies

were in tension with one another as she gained additional knowledge for teaching mathematics. This knowledge allowed her to orchestrate instruction, which supported students in learning rigorous mathematics and metacognitive skills.

- The data, including extensive interviews with Jennings and her students, classroom observations, and reflections, provide insight into the professional transformation that occurred within Jennings' practice as she enacted the new, shared repertoire in her classroom. She enacts this new, shared repertoire by developing a classroom culture and by implementing learner-centered strategies. These strategies focused on providing students with metacognitive experiences, high quality formative learning experiences, and tools to help them interact with the content. The new repertoire resulted in improved student learning.

Chapter Five
Discussion, Implications, and Further Research

Discussion

The central question that spurred this research was: *How did one teacher, with 20 years of experience in the classroom, make significant and meaningful changes in her teaching practice (of high school mathematics) after participating in a multiple-year professional development project?*

We know that transformative changes in classroom practice are difficult to achieve and sustain, particularly with experienced teachers. Actually, most professional development does not typically target teachers with as many years of experience as this case study teacher or her cohort peers (12-20 years).

Danielle was able to negotiate her participation in a community of practice through (1) *intellectual partnership,* (2) *authentic, legitimate participation in a collaboratively forming CoP,* that involved the (3) *development of a new shared pedagogical repertoire*. The partnerships involved more than just specific pedagogical strategies and ongoing support from a peer group; they developed through joint enterprise in challenging, thoughtful, and professional interactions.

Several implications emerged from this case study that could be used to inform teacher development and the design of professional programming that might support transformative changes in teacher practice and contribute to recruiting experienced teachers to such programs.

Implications for Teacher Development for Experienced Teachers

The research is clear that changing teacher practice is a challenging endeavor, especially for experienced teachers like Danielle Jennings. In this case, Jennings was

already perceived as a good teacher by her administration, and she entered the Appalachian Teacher Partner Project having considerable content knowledge. Yet, she was dissatisfied with her practice and her student learning results, and wanted to improve. Ultimately, Jennings came into the project with a self-identified need for her participation. Selecting teachers who have a desire to learn more or want to enhance their practice should be an important consideration for project leadership in the selection of participants for professional programming opportunities.

The *intellectual* partnerships that formed through the Appalachian Teacher Partner Project (ATPP) played a critical role in the development of the new shared repertoire that Jennings implemented in her classroom. Her *Peer CoP*, the External Educational Experts, and the Regional Teacher Partners all appeared to play a valuable role as *intellectual* partners with Jennings and in the creation of the shared repertoire. This partnership was not one-sided; both sides clarified, deepened, or changed their understanding about a problem of practice as a result of their interactions. Further, each group needed knowledge of the content and of the transformative practices to provide or act on quality feedback that resulted in the creation of a new shared repertoire for Jennings and her *Peer CoP*.

Eisner (1992) asserts that experienced teachers can be resistant when changes in policies, society, expectations, or leadership require different content and new repertoires. As part of external state mandates, Danielle Jennings was expected to change her practice. The goal of the Appalachian Teacher Partner Project was to align project experiences to increase the likelihood that teachers would transform their practice to meet the mandates. Based on Jennings' reports and reflections, alignment to the organization enabled her to

provide her students and other teachers with the competencies that they needed to meet more rigorous standards.

Hattie (2003) identified five dimensions that distinguish an expert teacher from an experienced teacher. “Expert teachers have high levels of knowledge and understanding of the subjects that they teach, can guide learning to desirable surface and deep outcomes, can successfully monitor learning and provide feedback that assist students to progress, can attend to more attitudinal attributes of learning (especially developing self-efficacy and mastery motivation), and can provide defensible evidence of positive impacts of the teaching on student learning” (p.28). Before her participation in the ATPP and her profession growth with her *Peer CoP*, Jennings self-reported that she had a high level of content knowledge but that she needed additional competencies to meet the learning needs of her classroom. So, if Hattie and Jaeger’s five dimensions are indeed required to develop teacher expertise, then it stands to reason that Jennings’ transformative experience led her to develop the other dimensions.

The data in this case study confirm that elements beside content knowledge were critical to Jennings’ development into an expert teacher. A social element was needed, which in Jennings’ case was the *Peer CoP*. An expert element was also needed, someone with experience, a well-stocked tool bag, and a willingness to be an “*intellectual”* partner, not just a dispenser of knowledge.

Wenger (1998) discussed the need for a tension to exist between experience and competence. In order to improve practice, Wenger said, teacher competencies must increase as their experience increases. More often than not, teachers’ competencies stagnate, even though their experience increases, as evidenced by little to no gains in

student achievement over time. Experience does not equate to competency. However, leadership often comes to regard experienced teachers as good, good enough, or too set in their ways to change. Over time, this designation may contribute to an erosion in teachers' professional confidence and knowledge. Data from this study show how important confidence is to improving teacher practice. Indeed, it was critical for Danielle to feel that Silver valued her work, and, ultimately, this professional interaction improved her confidence and led eventually to her decision to implement changes to her practice.

Successful change requires that a person or group (mentor or coach) be charged with ongoing support or technical assistance (Hamilton & McInerny, 2000; Gerston, Morvant, & Brengelman, 1995). Traditional mentoring may not be the right strategy, especially for experienced teachers. Developing *intellectual* partnerships may be a better option.

Role of *Peer Community of Practice (CoP)*

Jennings and the members of her *Peer CoP* had several things in common that may have led to their development as a *Peer CoP*. First, they had similar years of teaching experience and were all secondary mathematics teachers who had taught or are teaching similar courses. They all taught in Appalachian schools and often lived and worked in the communities where they were raised. Further, all members of the *Peer CoP* were affected by an external state mandate at the same time. Therefore, they all began the project with similar backgrounds and similar needs, which appear to have allowed for *intellectual* partnerships to form.

Would Jennings have achieved the changes to her practice without her *Peer CoP*? It's unlikely. Transformative changes seem more likely if the giver and the receiver

negotiate meaning and learn from that interaction, as it appears happened with Jennings' *Peer CoP*. We do know that the *Peer CoP* in this study appeared to have supported Danielle's development of pedagogical content knowledge through the intellectual partnership that resulted.

Role of Regional Teacher Partners

The Regional Teacher Partners (RTPs) accompanied the Appalachian Teacher Partners (ATPs) on trips to conferences as they interacted with experts who the RTPs often already had a relationship with. At a minimum, the RTPs were familiar with the experts' research and had been utilizing resources that the expert had created. This allowed the RTP to facilitate rich conversations on site with the ATPs. An implication for future project design would be to consider involving teachers, like the RTPs, who have already gone through the learning journey in support of existing projects. Like students in a classroom, these teacher partners are able to relate to participants in a way that other project leaders who are more removed from the day-to-day realities of teaching cannot.

The Regional Teacher Partners (RTPs) played a key role supporting the development of Danielle Jennings by serving as her learning partner, mentor, and coordinator of her learning. The RTPs were a highly skilled group, who had experience and competencies they had developed through participation in an Appalachian mathematics project similar to Jennings'. Their competency and experience have continued to grow through continued interaction with their intellectual partnership groups and through additional National Science Foundation, Kentucky Math and Science Partnership projects that have provided them with training over the past 15 years.

The ATPP project capitalized on the expertise of the Regional Teacher Partners by using them to help support the learning of Jennings and her peers. Jennings valued the interaction and support that the RTPs were able to provide. The RTPs' backgrounds and experiences resulted in their unique ability to serve as *intellectual* partners with Jennings as they provided descriptive feedback on her unit of study. Also, their feedback before and after classroom observations allowed Jennings to develop and implement a new repertoire of tools and strategies in her classroom that helped improve her students' learning.

Role of External Expert Interaction

Creative energy for planning learning experiences seems to be elevated when an *intellectual* partnership develops between teachers and educational experts. For Jennings, the *intellectual* partnership that was created as part of these interactions affected her practice and her students' learning. The personal relationship and collegial respect that both parties experienced was critical to the interactions and the subsequent development of a shared repertoire.

Implication for Future Design of Professional Dev. Projects for Experienced Teachers

Wenger et. al., (2002) identified the Stages of Development for a community of practice as the members coalesce through ongoing and sustained interactions. These stages were useful in this study as a mechanism to illustrate the development of the CoP over time. An implication for designers of future projects may well be to provide the scaffolding of initial conditions that would allow for progression through each of the

development stages, particularly among individuals with a common goal and a growth mindset.

We learn from Borko's (2004) review of the "terrain" of professional development that programs that focus on subject matter are successful in building teacher content knowledge (p. 5-6). Particularly effective, she noted, are those programs that engage teachers as active learners of content using pedagogical strategies similar to those that educators are encouraged to use with their students. In addition to explicit focus on content, the way that content is presented in professional development matters for teacher learners. Therefore, a consideration for the pedagogical focus of teacher learning is theories of how teachers—or adults in general—learn. Elmore (2002) argued that "a clearly articulated theory of adult learning is part of the consensus around qualities for highly effective professional development" (p.7). However, "few studies have used theories of teacher learning and change to inform professional learning" (Smylie, 1995, p.93). For effective teacher learning to occur, several areas, described below, are essential considerations for program designers.

Role of Coordinated Structure

Structures need to establish the conditions from which *intellectual* partnership, joint enterprise, and the development of a new collaboratively valued shared repertoire can transform practice. Teachers need to be encouraged to honestly discuss and articulate their perceived deficiencies in their classrooms. They may know that their students aren't *really* learning, but they may not have the wherewithal, including the time, financial resources, or know-how, to do something about it. They may also be under pressure from local leadership to implement new policy or mandates. In this study, time and alignment to

external mandates that were required of the school organization were part of the coordinated structure of the ATPP design.

Time

Time, in the form of release time from the classroom, seems to have played a key role in the development of Danielle's leadership role within the project and among her *Peer Community of Practice*. Her release time also appears to have played a role in her ability to make sense of her experiences and possibly learn and apply them at a different level than the other participants who did not have release time. This is not necessarily a new finding, but in the case of Danielle and her peer group, the essential nature of release time for collaboration and reflection is necessary, especially when developing a new shared reportoire.

We know that teachers are often exposed to a carousel of professional development. But these types of training experiences are typically insufficient for changing teacher practice through development of a new repertoire. Therefore, teachers need space and time to discuss problems of practice with like-minded individuals who have similar backgrounds.

Alignment to the organization

Every school setting is unique, and a one-size-fits-all pedagogical strategy or policy reform will not be successful (Easton, 2008a, 2008b; Guskey, 1995). In this case study, it appears that the alignment of the ATPP project goals with what was required of Jennings in her school district provided her "just-in-time" support. This support later allowed her to not only affect student learning in her classroom but to share her repertoire

with others in her district. The more that a project can demonstrate how it aligns with the organization's goals, the more buy-in it is likely to receive from participants.

Role of Learning Culture

Wenger (1998) asserts that

> Schools gain relevance not just by the content of their teaching—much of which can be acquired just as well in other circumstances—but by the experience of identity that students can engage in while there. Consequently, deep transformative experiences that involve new dimensions of identification and negotiability, new forms of membership, and ownership in meaning—are likely to be more widely significant in terms of long-term ramifications of learning"…(p.268).

In this case, we learned from Jennings', an experienced teacher, that she appreciated being with teachers who had backgrounds and experience similar to her own. Despite their similarities, these teachers were still able to engage as *intellectual* partners as they learned together and supported the development of a new shared repertoire. However, it is important to keep in mind that expert teachers, namely the Regional Teacher Partners, also had similar backgrounds and experience, which may have contributed to the ATPs' success as *intellectual* partners. Therefore, a consideration for future research would be a deeper dive into the role of participant culture and the need for project leadership to understand that culture in order to be effective.

Role of Financial Support

Research in K-12 programs and this study indicate the need for sustained and intensive professional learning experiences for teachers so that an underlying tension can

exist between teacher competency and experience—a critical factor in improving teacher practice. The NSF funding of the Appalachian Teacher Partner Project provided a mechanism wherein experienced teachers could obtain the necessary resources and learning experiences that allowed for their legitimate participation in intellectual partnerships. These relationships and intellectual partnerships played a key role in Danielle changing her practice and being able to develop the repertoire.

Comprehensive professional learning is a key factor in changing teacher practice. Eduational decision makers, therefore, should be prepared to fund comprehensive and sustained approaches like the kind Jennings experienced during her participation in the ATPP.

Role of Intellectual Partnerships

Intellectual partnership appears to be an avenue worth exploring if we want the tension between a teacher's experience and competency to remain high. The intellectual partnerships in this case study were successful for Jennings. In designing future projects, it is important to examine the planned experiences to determine the degree to which they allow for the development of intellectual partnerships over time.

Further, leaders who are charged with orchestrating professional learning experiences must determine the degree of competence and experience an individual participant brings to the table so they can support the idea of competence being in tension with experience. Until I did this study, it did not occur to me how important this tension is. We are fortunate to have access to research that is defining the competencies that teachers need to be deemed experts. As future projects are planned, these competencies should remain in the forefront.

Role of Sustained Engagement

In the introduction to their book, *Professional Development in Education: New Paradigms and Practices*, Guskey and Huberman (1995) wrote:

Never before in education has there been greater recognition of the need for ongoing professional development. The current emphasis on professional development comes from growing recognition of education as a dynamic, professional field. Educational researchers are constantly discovering new knowledge about teaching and learning processes [and] educators must keep abreast of this emerging knowledge base and be prepared to use it to continually refine their conceptual and craft skills. (p. 1)

It is likely that the length and design of the ATPP enabled Jennings to emerge more strongly as an expert mathematics teacher than would have been the case had her participation been cut short and the project lasted only a short period of time. The findings from this study suggest that longer-term projects that focus on specific experiences and support ongoing collegiality and reflection on practice are more fruitful in improving teacher practice. Therefore, professional learning experiences that are short in duration without the opportunity for sense-making with like-minded colleagues and time to practice and refine practices should not be considered the norm. Maintaining relationships with project participants' administrators is also critical when undertaking long-term projects. Fostering these relationships helps to maintain a high level of local support and to ensure the continued alignment to external mandates.

Implications for Research

We know that the members of the *Peer CoP* all improved their practice and saw improvements in student learning. Future research should replicate this single case study to a broader case study of the entire *Peer CoP* group, using the current case findings as a lens. The findings from this research would allow for patterns across teachers to emerge and for the researcher to explore the degree to which the new shared repertoire was implemented in practice. The findings would also help determine the degree to which student learning improved and how long it has been sustained.

Research comparing the outcomes of participating in traditional and professional development like the one experienced by the ATPs is also needed. Findings from those investigations would provide state policymakers and professional developers with research-based information on which to base decisions about what types of professional development to offer and under what conditions such models are most effective in promoting teacher change and student achievement.

We need further research to identify the reasons why most of the project ATPs, Jennings' cohort peers, gravitated toward Jennings. We know from this study that Jennings had experience and competencies that others in the group did not possess initially. Those experiences included her coaching training and her role as a leadership intern. During her year-long internship, Jennings' school was provided funding for her part-time release from teaching. In addition, her part-time release allowed her to share more actively and create or adapt tools for use in the classroom. These reasons may partially explain why others in the cohort community of practice gravitated toward, and

connected with, Jennings. However, to know the answer more definitively, more research would need to be conducted with others within the cohort community of practice.

Finally, we need a mechanism to collect more data on the background, needs, and formal education of educators in order to plan effective learning experiences for teachers. We know from Wagner's (2004) research that this investment is necessary:

> Transforming education from a craft to a profession is the greatest challenge school and district leaders face. Above all, "professionalizing" education means creating ongoing opportunities for discussion of problems of practice at every level in the organization. It is only through such discussion that we can collaboratively create new knowledge about how to continuously improve learning, teaching, and leadership (p. 41).

Conclusion:

This holistic, single case study provided insights into how an experience teacher was able to negotiate participation in a CoP to change her classroom practice and positively affect the learning climate and students' learning in her AP calculus classroom. The findings suggest ways in which dedicated, experienced teachers, who are often overlooked in professional development planning, may re-energize their practice and better meet the needs of their students.

Appendix A

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Withdrawal

IRB Number
14-0308-P4S

TO: Kimberly Zeidler-Watters
UK/Lexmark Center for Innovation in Math and Science Ed
1737 Russell Cave Rd
Lexington, KY 40505-1600
PI phone #: (859) 576-4286

FROM: Institutional Review Board
Office of Research Integrity

SUBJECT: Withdrawal of Protocol Application 14-0308-P4S

DATE: April 25, 2014

This is to confirm that the Office of Research Integrity has closed the protocol application entitled:

Transformative Participation in Professional Community: A Holistic Case Study of One Experienced Teacher's Evolving Practice

Due to the follow-up nature of the research being conducted and the fact only one human subject would be involved, the IRB determined this was a case study and did not require IRB review.

If, in the future, you wish to change aspects of this project that may affect the IRB's determination, please contact the Office of Research Integrity for assistance. A new application may be required.

Appendix B

Additional Interview Questions

1. Tell me more about the people that you identified that you did not know prior to the project but who you have worked with recently? What experiences brought you together? Why do you think you clicked with these folks more than others?

2. What are some stories that you will always remember about your interactions with other ATPs or group leaders around improved classroom practice?

3. Would you share more specifically the interactions with project participants about how you applied to or modified your practice in regard to the key aspects of the ATP project: (unit of study; differentiation; classroom level assessment; habits of mind).
    - In what ways did the other ATPs help to inform, modify, or help you better understand these strategies?
    - In what ways were you supported as you worked to implement ideas shared as part of the ATP project? What kind of support?
    - What strategies did you work on with other ATPs to refine before using in your classroom?
    - Can you think of a time when a strategy or something you were teaching did not go as expected during the ATP project? In what ways were you able to use the other ATPs to find support? What kind of support was offered?
    - Do you have an example when you learned something you had not thought of from another ATP that you later incorporated into your practice?

4. In what ways have you and the other ATPs interacted with one another since the project ended in December 2013 related to continuing to improve your practice?

   What were the benefits you derived from the contacts and interactions?

   What is discussed or shared during the contacts?

5. Thinking about the Networking survey that you completed. What do you predict the results would be?

   Let's look at the sociograms and talk about a few, I am curious about your perception of the results.

   What do you observe from the data?

6. What aspects of the ATP project helped resulted in you forming the relations with other ATP that you now have and have benefited from?

7. Tell me about ways that you participated with others prior to the ATP project?

8. How many years have you taught AP?

   Who else teaches the same course as you in your school?

   What support was offered to you in order to prepare to offer AP at your school?

   Has your approach to the AP course changed over the past few years?

   What do you attribute the changes?

9. Are there activities, meetings, problem solving sessions in which you and other AP teachers in your school participated?

   What has been the nature of those interactions?

   Were there benefits you derived from these interaction?

   What impact has resulted from the interactions?

10. How do you interact with other AP mathematics teachers either inside or outside your school?

    What is the nature of the participation? How do you participate?

    Were there benefits to your practice?

    What impact has resulted from the interactions?

Appendix C

1. AMSP Master Teacher Project: Network Survey

This survey is part of the final study of the AMSP Master Teacher Project. The purpose of the survey is to help us examine the professional network that has developed among the persons involved in the project. We know that in a typical network, different people have different sets of connections, and the network can function differently for the various people involved. We wish to explore and look for patterns in the ATP network. The items in this survey will help us to do this. Results will be summarized and discussed as part of our final report to the National Science Foundation.

Each page of the survey contains a list of the persons involved in the Master Teacher Project – ATPs, Regional Teacher Partners, and university mentors – and will ask you for information on how you may (or may not) have worked with or been connected to each of them. In order for us to get an accurate picture of the different aspects of the network, it is very important that you respond completely to each item. Do not leave blanks.

There are no right or wrong answers to these questions, only your perceptions and opinions. Please answer the items with what you really think, not how you think someone would expect you to respond. Please be assured that the information you provide here will be kept confidential, and will not be shared with anyone. Only the project's external evaluator will see your individual responses. Reporting of the results will present summary data about the network as a whole, without identifying particular persons.

On a few items, you are asked to select up to 5 names that fit a given description. Do not feel you have to mark the maximum; fewer is fine, according to what you really think. If more than five names seem to fit the description, narrow your choices to the five that fit the best. Again, there are no right or wrong answers.

The survey should require about 10 minutes to complete. You will need to respond to the entire survey in one session; you will not be able to save it and come back to it.

If you have questions or concerns about this survey, please contact the Master Teacher Project's external evaluator, Dr. Michael Howard, at michaelnhoward@earthlink.net.

Thank you in advance for providing your thoughtful responses on this survey. Please start the survey now by clicking on the button below.

2.

***1. Enter your name in the box below. This is only used to track who has and has not yet responded to the survey.**

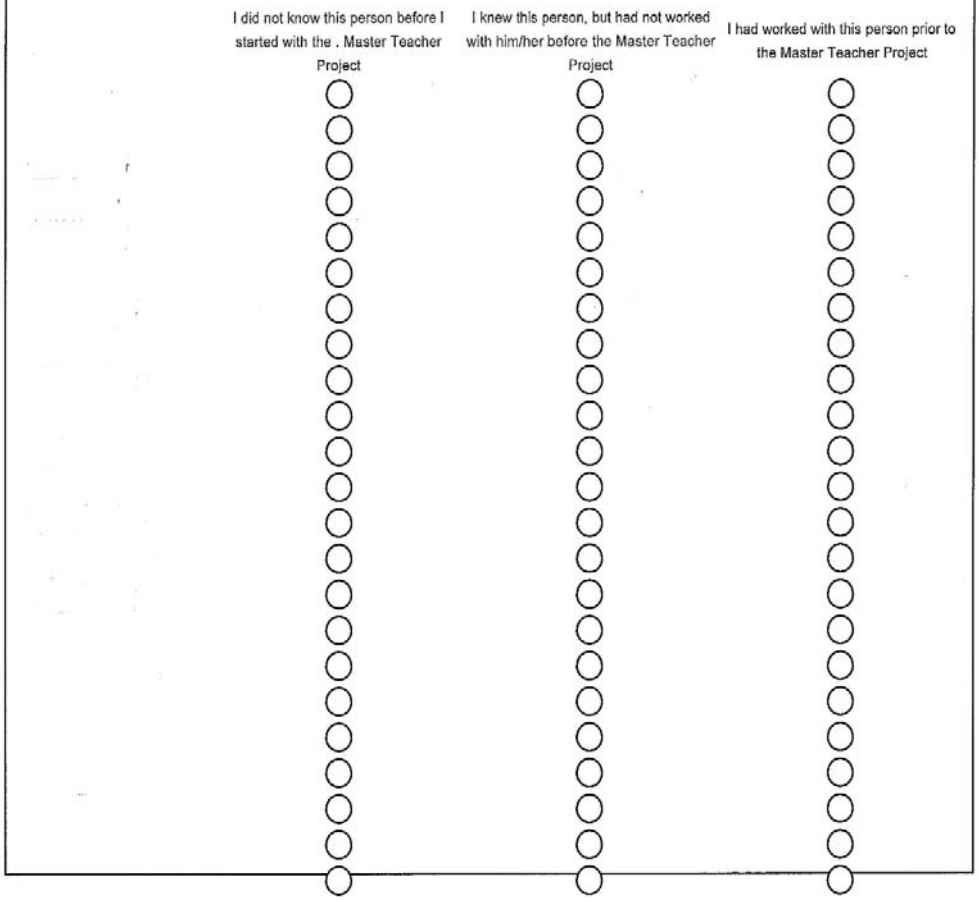
3. Before the Master Teacher Project

The next two items on the survey ask you to think back to the beginning of your participation in the Master Teacher Project.

***2. The list below contains the names of the persons who have been involved in the Master Teacher Project. For each person on the list, mark the choice that best describes your relationship with that person before you began working with the Master Teacher Project.**

In this item and all the other items on the survey, ATPs are listed first, then the PIMSER facilitators, and then the university mentors.

***** Please mark a choice for every name on the list (except your own name, of course). *****



4.

***3. A leader is not always the person who convenes the group or plans the agenda, but can be anyone who is influential in moving the group forward and making it successful.**

Think back to 2009, shortly after you had begun meeting with the Master Teacher Project group. Back then, which persons on the list would you have identified as leaders in the group?

(Mark up to 5 names. It is okay to mark fewer names; it is also okay to select yourself, if appropriate. If you think no one fits the description, mark the last response in the list.)

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5. Back to the Present Day

The remaining items on the survey ask for your current perceptions.

***4. For each person on the list, mark the choice that best describes your present relationship in the Master Teacher Project.**

***** Please mark a choice for every name on the list (except your own name, of course). *****

	I do not really know this person	I know this person, but have not worked closely with him/her in the Master Teacher Project	I have worked closely with this person in the Master Teacher Project
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6.

***5. A leader is not always the person who convenes the group or plans the agenda, but can be anyone who is influential in moving the group forward and making it successful.**

Which persons on the list do you currently consider to be leaders in the group?

(Mark up to 5 names. It is okay to mark fewer names; it is also okay to select yourself, if appropriate. If you think no one fits the description, mark the last response in the list.)

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7.

Our study of the ATP network is interested in the various roles that people play in the network. Some of these roles primarily involve providing knowledge or skill to the group, while other roles primarily involve fostering professional relationships and connections. The final few items in the survey explore these ideas.

***6. Content knowledge in the discipline is important for planning and delivering quality instruction.**

Which persons on the list have you found to be the most valuable sources of practical content knowledge?

(Mark up to 5 names. It is okay to mark fewer names; it is also okay to select yourself, if appropriate. If you think no one fits the description, mark the last response in the list.)

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8.

***7. Effective instruction also depends on having lessons that are engaging to students and use strategies that build understanding.**

Which persons on the list have you found to be the most valuable sources of effective teaching ideas?

(Mark up to 5 names. It is okay to mark fewer names; it is also okay to select yourself, if appropriate. If you think no one fits the description, mark the last response in the list.)

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9.

***8. ATPs are expected to help foster changes in the local mathematics or science program beyond their own classroom. This is typically not an easy thing to accomplish.**

Which persons on the list have you found to be the most savvy about how to achieve changes at the local level?

(Mark up to 5 names. It is okay to mark fewer names; it is also okay to select yourself, if appropriate. If you think no one fits the description, mark the last response in the list.)

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10.

***9. Innovative people come up with new ways of doing things, provide fresh perspectives on issues, encourage different approaches to addressing a problem.**

Which persons on the list do you consider the most innovative?

(Mark up to 5 names. It is okay to mark fewer names; it is also okay to select yourself, if appropriate. If you think no one fits the description, mark the last response in the list.)

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11.

***10. Which persons on the list have been the most influential for your development as an Appalachian Teacher Partner? (Note: If you are not an ATP, please mark the last response on the list.)**

(Mark up to 5 names. It is okay to mark fewer names. If you think no one fits the description, mark the next-to-last response in the list.)

- ☐ No one fits the description
- ☐ Not applicable (I am not an ATP)

12.

***11. A colleague is someone with whom you would choose to work or interact on a professional basis. A colleague can be a source of ideas, assistance, support, or inspiration as you seek to do your job.**

Who do you consider to be your closest colleagues in the Master Teacher Project?

(Mark up to 5 names. It is okay to mark fewer names. If you think no one fits the description, mark the last response in the list.)

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13. Thank you

Thank you for your responses. We appreciate you taking the time to provide your input into this study.

If you have questions about the survey or the procedures, contact Dr. Michael Howard, Master Teacher Project external evaluator, michaelnhoward@earthlink.net

When you click the "Finish" button, your responses to the survey will be recorded and this browser window will close.

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Yoon, K. S., Duncan, T., Lee, S. W. Y., Scarloss, B., & Shapley, K. (2007). Reviewing the evidence on how teacher professional development affects student achievement (Issues and Answers Report, REL 2007 No. 033). Washington, DC: *U.S. Department of Education, Regional Educational Laboratory Southwest.*

VITA

Kimberly J. Zeidler-Watters

ACADEMIC DEGREES

Masters of Education (MEd)	Loyola College, December 1996 College of Education, Curriculum & Instruction Emphasis Area: Science
Bachelor of Arts (BA)	West Liberty State College, December 1986 College of Education, Elementary Education Emphasis Area: K-8

WORK EXPERIENCE

2013-present	*Director, Partnership Institute for Math and Science Education Reform, College of Education, University of Kentucky, College of Education.*
2006-2013	*Director, P-12 Math and Science Outreach Unit of the Partnership Institute for Math and Science Education Reform, University of Kentucky, Office of the Provost.*
1996-2006	*Director, Appalachian Rural Systemic Initiative, University of Kentucky, Lexington, Kentucky* Oversee the daily activities of the Resource Collaborative; Provide schools with technical assistance and broker services in the area of mathematics and science; Supervise a 7 person staff; Oversee the implementation of grant accounts totaling more than 1.5 million dollars annually. Principal Investigator, Appalachian Rural Systemic Initiative Master Teacher Project funded by the National Science Foundation Provide training and oversee the work of 6 Master Teachers (Regional Teacher Partners).

PROFESSIONAL DEVELOPMENT ACTIVITIES: K-12 Education and Leadership

- Ongoing *Intellectual* Partnerships: ongoing with classroom assessment experts Shirley Clarke, Richard Stiggins, Jan Chappuis, Carol Commodore, Cassandra Erkens; mathematics national leaders Jennifer Bay-Williams and the late Ron

Pelfrey and Wimberly Royster; national evaluators Mark St. John, Stephen Henderson and Michael N. Howard.

- Visible Learning Institute with John Hattie. (February, 2015)
- Learning Forward National Conference (2012)
- Assessment Summit (2012)
- Assessment Training Institute (ATI) conference for leadership on Formative Assessment (May 2006)
- National Association of Curriculum and Supervision Conference, New Orleans, LA (March 2004)
- Participated in three day pre-conference administrators leadership institute facilitated by Pam Robbins as part of the Association of Curriculum and Supervision Conference (March 2004)
- Using Data Getting Results (August – January 2003)
- Exploratorium's Institute on Formative Assessment national expert Harlan, W. (November 2003)
- Exploratorium's Institute on Inquiry (January 2002)
- Appalachian Education Laboratory Leadership training on Teaching Reading in Science and Mathematics (January, 2002)

PROFESSIONAL AFFLIATIONS

- Association for Supervision and Curriculum Development
- Phi Delta Kappa International
- *National Science Teachers Association*
- National Council of Teachers of Mathematics